DOCUMENT RESUME

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IDENTIFIERS	*Aerospace Medicine; Fruits; Meat Inspection; Military Curriculum Project; Vegetables

ABSTRACT

These military-developed curriculum materials consist of five volumes of text information, student workbooks, and supplements for use in training veterinary specialists. Covered in the individual volumes are the following topics: the veterinary airman, administration, and statistical procedures; veterinary microbiology, consumer-level quality audit program, food technology, operational ration and egg inspection; meat inspection; animal service, military working dogs, fresh fruits and vegetables, waterfoods, and dairy products; and support of the aerospace medicine program. Each chapter contains objectives, readings, review exercises, and answers for student self-study and evaluation. (MN)

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MILITARY CURRICULUM MATERIALS

The military-developed curriculum materials in this course package were selected by the National Center for Research in Vocational Education Military Curriculum Project for dissemination to the six regional Curriculum Coordination Centers and other instructional materials agencies. The purpose of disseminating these courses was to make curriculum materials developed by the military more accessible to vocational educators in the civilian setting.

The course materials were acquired, evaluated by project staff and practitioners in the field, and prepared for dissemination. Materials which were specific to the military were deleted, copyrighted materials were either omitted or approval for their use was obtained. These course packages contain curriculum resource materials which can be adapted to support vocational instruction and curriculum development.

The National Center Mission Statement

The National Center for Research in Vocational Education's mission is to increase the ability of diverse agencies, institutions, and organizations to solve educational problems relating to individual career planning, preparation, and progression. The National Center fulfills its mission by:

- Generating knowledge through research
- Developing educational programs and products
- Evaluating individual program needs and outcomes
- Installing educational programs and products
- Operating information systems and services
- Conducting leadership development and training programs

FOR FURTHER INFORMATION ABOUT
Military Curriculum Materials
WRITE OR CALL
Program Information Office
The National Center for Research in Vocational Education
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Military Curriculum Materials for Vocational and Technical Education

Information and Field Services Division

The National Center for Research in Vocational Education

Military Curriculum Materials Dissemination Is . . .

an activity to increase the accessibility of military-developed curriculum materials to vocational and technical educators.

This project, funded by the U.S. Office of Education, includes the identification and acquisition of curriculum materials in print form from the Coast Guard, Air Force, Army, Marine Corps and Navy.

Access to military curriculum materials is provided through a "Joint Memorandum of Understanding" between the U.S. Office of Education and the Department of Defense.

The acquired materials are reviewed by staff and subject matter specialists, and courses deemed applicable to vocational and technical education are selected for dissemination.

The National Center for Research in Vocational Education is the U.S. Office of Education's designated representative to acquire the materials and conduct the project activities.

Project Staff:

Wesley E. Budke, Ph.D., Director
National Center Clearinghouse

Shirley A. Chase, Ph.D.
Project Director

What Materials Are Available?

One hundred twenty courses on microfiche (thirteen in paper form) and descriptions of each have been provided to the vocational Curriculum Coordination Centers and other instructional materials agencies for dissemination.

Course materials include programmed instruction, curriculum outlines, instructor guides, student workbooks and technical manuals.

The 120 courses represent the following sixteen vocational subject areas:

- Agriculture
- Aviation
- Building & Construction Trades
- Clerical Occupations
- Communications
- Drafting
- Electronics
- Engine Mechanics
- Food Service
- Health
- Heating & Air Conditioning
- Machine Shop
- Management & Supervision
- Meteorology & Navigation
- Photography
- Public Service

The number of courses and the subject areas represented will expand as additional materials with application to vocational and technical education are identified and selected for dissemination.

How Can These Materials Be Obtained?

Contact the Curriculum Coordination Center in your region for information on obtaining materials (e.g., availability and cost). They will respond to your request directly or refer you to an instructional materials agency closer to you.

CURRICULUM COORDINATION CENTERS

EAST CENTRAL
Rebecca S. Douglass
Director
100 North First Street
Springfield, IL 62777
217/782-0759

MIDWEST
Robert Patton
Director
1515 West Sixth Ave.
Stillwater, OK 74704
405/377-2000

NORTHEAST
Joseph F. Kelly, Ph.D.
Director
225 West State Street
Trenton, NJ 08625
609/292-6562

NORTHWEST
William Daniels
Director
Building 17
Airdustrial Park
Olympia, WA 98504
206/753-0879

SOUTHEAST
James F. Shill, Ph.D.
Director
Mississippi State University
Drawer DX
Mississippi State, MS 39762
601/325-2510

WESTERN
Lawrence F. H. Zane, Ph.D.
Director
1776 University Ave.
Honolulu, HI 96822
808/948-7834

VETERINARY SPECIALIST

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VETERINARY SPECIALIST

Correspondence Course

1-2

Developed by:

United States Air Force

Development and Review Dates:

March 1974

Occupational Area:

Agriculture

Cost:	**Print Pages:**
$8.00	393

Availability:
Military Curriculum Project, The Center
for Vocational Education, 1960 Kenny
Rd., Columbus, OH 43210

Suggested Background:

Biology

Target Audiences:

Grades 10-adult

Organization of Materials:

Text; student workbooks with objectives, assignments, review exercises and answers, and volume review exercises; supplementary material

Type of Instruction:

Individualized, self-paced

Type of Materials:		**No. of Pages:**	**Average Completion Time:**
Volume 1 –	*Veterinary Airman, Administration, and Statistical Procedures*	16	Flexible
	Workbook	15	
Volume 2 –	*Veterinary Microbiology; Consumer Level Quality Audit Program; Food Technology; Operational Ration and Egg Inspection*	33	Flexible
	Workbook	23	
Volume 3 –	*Meat Inspection*	61	Flexible
	Workbook	42	
Volume 4 –	*Animal Service; Military Working Dogs; Fresh Fruits and Vegitables; Waterfoods, Dairy Products*	45	Flexible
	Workbook	50	
Volume 5 –	*Support of the Aerospace Medicine Program*	34	Flexible
	Workbook	25	
Pamphlet of Sampling Plan Tables		17	

Course Description

This course is designed to upgrade Apprentice (semi-skilled) workers to the Specialist (skilled) level. Many of the tasks at this level deal with food inspection. Several chapters dealing with military procedures and forms of inspection were deleted. The following are the duties of a Veterinary Specialist:

- Inspects civilian establishments supplying food products
- Conducts procurement inspection and grading
- Inspects foods in warehouses
- Assists in epidemiological and other investigations
- Assists in veterinary service animal activities
- Prepares and maintains veterinary records, reports, and correspondence
- Supervises veterinary personnel

This course consists of five volumes of text material, student workbooks, and supplements.

Volume 1 – *The Veterinary Airman, Administration and Statistical Procedures* contains a chapter on inspection by attributes which explains terms and definitions of sampling procedures, sampling techniques, records and reports, and is accompanied by random number tables and example records. The three additional chapters in Volume 1 were deleted because they referred to specific military organization and forms.

Volume 2 – *Veterinary Microbiology; Consumer Level Quality Audit Programs; Food Technology; Operational Ration and Egg Inspection* contains five chapters. The first chapter on Veterinary Microbiology discusses cells, microorganisms, sterilization, the microscope, collecting and submitting specimens for laboratory analysis, and common laboratory procedures. The third chapter covers food technology. The second chapter on the Consumer Level Quality Audit Program, the fourth chapter on Operational Rations, and the fifth chapter on Egg Inspection were deleted.

Volume 3 – *Meat Inspection* contains three chapters covering the production, grading, categories, and processing of beef, veal, lamb, pork, sausage, and poultry. The first chapter discusses the anatomy of food animals.

Volume 4 – *Animal Service; Military Working Dogs; Fresh Fruits and Vegetables; Waterfoods; Dairy Products* contains a chapter on procedures related to quarantine and clinic operation, and diseases related to small animals. The second chapter which explains the criteria for the selection of military working dogs and the principles for maintaining their good health has been deleted. The remaining three chapters discuss ways to assure that fruits, vegetables, waterfoods, and diary products are wholesome, and safely preserved and packaged.

Volume 5 – *Support of the Aerospace Medicine Program* contains a chapter on the medical aspects of food handling discussing foodborne illnesses, prevention of foodborne illness, food and beverage vending, medical inspection of food service sanitation facilities, and insect and rodent control. Two sections from Chapter 1 on flight feeding and action in disease outbreaks, and the second chapter on nuclear, biological and chemical warfare were deleted because of references to specific military procedures and forms.

Each chapter contains objectives, readings, review exercises and answers for student self-study and evaluation. This course was designed for use in a laboratory or on-the-job learning situation. It contains a variety of information on food technology and small animals, but has a definite bias towards the military function of food inspection and processing.

Due to a misnumbering during an early stage, there are no pages 3 - 7.

DEPARTMENT OF THE AIR FORCE
Headquarters, US Air Force
Washington DC 20330

STS 908X0
(For AFSCs 90830/50/70)
25 March 1975

VETERINARY SPECIALIST
AND
VETERINARY TECHNICIAN

1. Purpose of this Specialty Training Standard (STS). As prescribed in AFR 8-13, this STS:

a. States in column 1 of attachment 1 the tasks, knowledges, and study references (SR) necessary for airmen to perform duties in the Veterinary ladder of the Airman Medical Career Field. These are based on Specialty Descriptions effective 1 October 1973 in AFM 39-1.

b. Indicates in columns 2A, 3A, and 4A of attachment 1 the minimum proficiency recommended for each task or knowledge for qualification at the 3, 5, and 7 skill level AFSCs. AFM 50-23 is the authority to change the proficiency level during JPG development when the local requirement is different from the skill level shown in this STS.

c. Shows in column 2A of attachment 1 the proficiency attained in Course 3ABR90830 (PDS Code EMQ) described in AFM 50-5. Proficiency code for the minimum proficiency recommended for the 3 skill level AFSC and the proficiency attained in the course is the same.

d. Provides basis for supervisors to plan and conduct individual OJT programs.

e. Provides a convenient record of on-the-job training completed when inserted in AF Form 623, "On-the-Job Training Record," and maintained in accordance with AFM 50-23.

2. Proficiency Code Key. Attachment 1 contains the Proficiency Code Key used to show proficiency level.

3. Career Development Channel of OJT. Satisfactory completion of CDC 90850 is mandatory for personnel training to AFSC 90850. Personnel training to AFSC 90870 will obtain knowledge training by using applicable study references listed in this STS and fulfill management training requirements specified in AFM 50-23. (See ECI Catalog and Guide for current CDC identification number for ordering purposes.)

4. Study Guidance for Weighted Airman Promotion System (WAPS). Specialty Knowledge Tests (SKTs) for promotion to E-5 are based on 5 skill level knowledge requirements. SKTs for promotion to E-6 and E-7 are based on 7 skill level knowledge requirements. SKT questions are based primarily on Career Development Courses (CDCs). However, some questions may be drawn from other references listed in this Specialty Training Standard. The CDCs for SKT study are maintained in the WAPS Study Reference Library. Other references listed should be available in the work area. Individual responsibilities are outlined in AFM 35-8, chapter 19, paragraph 19-3g.

5. Recommendations. Report to ATC/SG unsatisfactory performance of individual graduates or inadequacies of this STS. Refer to specific paragraphs of this STS. See AFR 50-38.

BY ORDER OF THE SECRETARY OF THE AIR FORCE

OFFICIAL

DAVID C. JONES, General, USAF
Chief of Staff

JACK R. BENSON, Colonel, USAF
Director of Administration

2 Attachments
1. Qualitative Requirements
2. SKT Review Reference

Supersedes STS 908X0, 24 January 1972; Change 1, 5 December 1972; Change 2, 12 February 1973; Change 3, 14 December 1973; Change 4, 11 April 1974

THIS BLOCK IS FOR IDENTIFICATION PURPOSES ONLY		
TRAINEE		
NAME	INITIALS *(In Writing)*	GRADE
ORGANIZATION		
IMMEDIATE SUPERVISOR'S NAME AND INITIALS *(In Writing)*		
N/I	N/I	
N/I	N/I	

QUALITATIVE REQUIREMENTS

PROFICIENCY CODE KEY		
	SCALE VALUE	DEFINITION: The Individual
TASK PERFORMANCE LEVELS	1	Can do simple parts of the task. Needs to be told or shown how to do most of the task. (EXTREMELY LIMITED)
	2	Can do most parts of the task. Needs help only on hardest parts. May not meet local demands for speed or accuracy. (PARTIALLY PROFICIENT)
	3	Can do all parts of the task. Needs only a spot check of completed work. Meets minimum local demands for speed and accuracy. (COMPETENT)
	4	Can do the complete task quickly and accurately. Can tell or show others how to do the task. (HIGHLY PROFICIENT)
* TASK KNOWLEDGE LEVELS	a	Can name parts, tools, and simple facts about the task. (NOMENCLATURE)
	b	Can determine step by step procedures for doing the task. (PROCEDURES)
	c	Can explain why and when the task must be done and why each step is needed. (OPERATING PRINCIPLES)
	d	Can predict, identify, and resolve problems about the task. (COMPLETE THEORY)
** SUBJECT KNOWLEDGE LEVELS	A	Can identify basic facts and terms about the subject. (FACTS)
	B	Can explain relationship of basic facts and state general principles about the subject. (PRINCIPLES)
	C	Can analyze facts and principles and draw conclusions about the subject. (ANALYSIS)
	D	Can evaluate conditions and make proper decisions about the subject. (EVALUATION)

– EXPLANATIONS –

* A task knowledge scale value may be used alone or with a task performance scale value to define a level of knowledge for a specific task. (Examples: b and 1b)

** A subject knowledge scale value is used alone to define a level of knowledge for a subject not directly related to any specific task, or for a subject common to several tasks.

– This mark is used alone instead of a scale value to show that no proficiency training is provided in the course, or that no proficiency is required at this skill level.

X This mark is used alone in course columns to show that training is not given due to limitations in resources.

	PROFICIENCY LEVEL, PROGRESS RECORD AND CERTIFICATION								
	2 3 Skill Level			3 5 Skill Level			4 7 Skill Level		
TASKS, KNOWLEDGES AND STUDY REFERENCES 1	A AFSC Crs	B Date OJT Started	C Date Completed & Trainee's Supervisor's Initials	A AFSC	B Date OJT Started	C Date Completed & Trainee's Supervisor's Initials	A AFSC Crs	B Date OJT Started	C Date Completed & Trainee's Supervisor's Initials
NOTE: Users may annotate lists of SRs to identify current references pending STS revision.									
1. CAREER LADDER PROGRESSION									
SR: AFP 39-7; AFR 39-4									
a. The airman career ladder and educational opportunities	B			C			C		
SR: AFMs 39-1 (atch 52, vol II). 213-1; AFVA 39-1									
b. Progression in career ladder 908X0	A			B			C		
SR: AFM 39-1 (atch 52, vol II); AFR 35-1; AFVA 39-1									
c. Duties of AFSCs 908X0, 90891									
SR: AFM 39-1 (atch 52, vol II)									
(1) AFSCs 90870, 90891	A			B			C		
(2) AFSCs 90830, 90850	B			C			C	NO ADVANCED COURSE	
d. Mission, organization, development, and function of the Medical Service and the Veterinary Service	A			B			C		
SR: AFR 20-28									
2. DISASTER PREPAREDNESS MEDICAL CARE AND FIRST AID PROCEDURES									
SR: AFMs 160-12 (chap 1), 160-34 (chap 5 and 9), 160-37									
a. Manage shock	2b/-			3c			3c		
b. Maintain effective respiration	2b/-			3c			3c		
c. Control hemorrhage	2b/-			3c			3c		
d. Perform emergency treatment of wounds	2b/-			3c			3c		
e. Manage fractures, burns, and injuries from chemical agents	2b/-			3c			3c		
f. Perform methods of hand and litter carries	2b/-			3c			3c		
g. Load and unload vehicles utilized for transportation of patients	2b/-			3c			3c		
h. Maintain military sanitation	a/-			1b			2b		

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1. TASKS, KNOWLEDGES AND STUDY REFERENCES	2. 3 Skill Level A AFSC/Crs	2. 3 Skill Level B Date OJT Started	2. 3 Skill Level C Date Completed & Trainee's Supervisor's Initials	3. 5 Skill Level A AFSC	3. 5 Skill Level B Date OJT Started	3. 5 Skill Level C Date Completed & Trainee's Supervisor's Initials	4. 7 Skill Level A AFSC/Crs	4. 7 Skill Level B Date OJT Started	4. 7 Skill Level C Date Completed & Trainee's Supervisor's Initials
3. COMMUNICATIONS SECURITY (TRANSMISSION SECURITY)									
SR: AFRs 205-1, 205-7									
a. Identify information as classified, unclassified, or of possible intelligence value	b			b			b		
b. Identify information as Top Secret, Confidential or For Official Use Only	b			b			b		
c. Select and recommend mode of transmission dictated by security and expediency required	b			b			b		
d. Observe security precautions involved in communications	b			b			b		
4. SUPERVISION AND TRAINING									
a. Supervision									
(1) Evaluate performance of personnel, counsel, and complete appropriate rating forms	-			2b			4c		
SR: AFMs 39-1 (atch 52, vol II), 39-62									
(2) Program work assignments for veterinary personnel	-			2b			4c		
SR: AFMs 39-1 (atch 52, vol II), 50-20									
(3) Prepare reports and correspondence, maintain files, and keep records related to veterinary service activities	2b			3c			4c		
SR: AFMs 10-1, 12-20, 12-50 (chap 1, 2, 3, and 10 (table 163-11)); AFRs 5-31, 13-1, 163-2, 163-5, 163-11; TA 9D4; Medical Materiel Catalog; DPSC Subsistence Inspection Manual; Guide for Subsistence Publications, Air Force Logistics Command (AFLC)									
(4) Responsibilities of veterinary noncommissioned officers	-			C			D		
SR: AFM 39-1 (atch 52, vol II); AFR 39-6									
(5) USAF Graduate Evaluation Program	-			C			C		
SR: AFR 50-38									
b. Training									

NO ADVANCED COURSE

14

1. TASKS, KNOWLEDGES AND STUDY REFERENCES	PROFICIENCY LEVEL, PROGRESS RECORD AND CERTIFICATION								
	2. 3 Skill Level			3. 5 Skill Level			4. 7 Skill Level		
	A AFSC Crs	B Date OJT Started	C Date Completed & Trainee's Supervisor's Initials	A AFSC	B Date OJT Started	C Date Completed & Trainee's Supervisor's Initials	A AFSC/Crs	B Date OJT Started	C Date Completed & Trainee's Supervisor's Initials
4b(1) Orient newly assigned personnel and make work assignments	-			2b			4c		
SR: AFMs 39-1 (atch 52, vol II), 50-20									
(2) Plan and conduct veterinary personnel training and maintain appropriate records	-			1b			3c		
SR: AFMs 39-1 (atch 52, vol II), 50-5, 50-20, 50-23									
(3) Utilize sound principles and techniques of instruction in veterinary training programs	-			2b			3c		
SR: AFMs 39-1 (atch 52, vol II), 50-23									
5. ENVIRONMENTAL SAFETY								NO ADVANCED COURSE	
SR: AFR 127-101 (chap 14)									
(a) Principles of general safety	B			C			C		
(b) Safety precautions during job performance	B			C			C		
6. PUBLICATIONS									
(a) Use indexes to locate official publications	1a/-			3c			3c		
SR: AFRs 0-2 Series and 5-4									
(b) Use official publications specifically pertaining to veterinary service activities	2b			3c			4c		
SR: AFMs 10-1, 12-20, 12-50 (chap 1, 2, 3, and 10 (table 163-11)); AFRs 5-31, 13-1, 163-2, 163-5, 163-11, TA 9D4; Medical Materiel Catalog; Defense Personnel Support Center (DPSC) Subsistence Inspection Manual; Guide for Subsistence Publications, Air Force Logistics Command (AFLC)									
7. VETERINARY MATERIEL PROCEDURES									
SR: AFM 67-1 (part II, vol 1); AFR 163-11									
a. Materiel procedures to include classification, identification, and budgeting	A			B			C		
b. Use indexes and supply catalogs	1a			2c			3c		
c. Prepare requests for issue and turn-in of supplies and equipment	1a			2c			3c		

1. TASKS, KNOWLEDGES AND STUDY REFERENCES	PROFICIENCY LEVEL, PROGRESS RECORD AND CERTIFICATION								
	2. 3 Skill Level			3. 5 Skill Level			4. 7 Skill Level		
	A AFSC/Crs	B Date OJT Started	C Date Completed & Trainee's Supervisor's Initials	A AFSC	B Date OJT Started	C Date Completed & Trainee's Supervisor's Initials	A AFSC/Crs	B Date OJT Started	C Date Completed & Trainee's Supervisor's Initials
7d. Property accountability and responsibility	A			B			C		
e. Report of survey system	A			B			C		
SR: AFM 177-111									
8. VETERINARY PROFESSIONAL RELATIONSHIPS									
SR: AFM 160-34 (chap 1); AFR 30-30									
a. Maintain professional standards of conduct	1b/b			3c			3c		
b. Promote good professional relations	1b/b			3c			3c		
c. Perform duties with a high standard of ethical conduct	1b/b			3c			3c		
9. VETERINARY STATISTICAL PROCEDURES									
SR: AFRs 74-10, 163-11; DPSC Subsistence Inspection Manual (sec 213.1, 215.2, 225.2, 225.3, 225.9); Air Force Services Office, COLEQUAP Handbook; Military Standard (MIL STD) 105									
a. Prepare sampling plans for inspection of subsistence items by use of statistical methods	2b			3c			4c	NO ADVANCED COURSE	
b. Conduct inspection of subsistence using statistical methods	2b			3c			4c		
c. Assist in evaluation of contractor inspection systems	1a			2b			3c		
d. Perform verification inspections	1a			2b			4c		
e. Prepare and complete records and reports pertaining to subsistence inspection by attributes and verification inspection	2b			3c			4c		
f. Perform COLEQUAP inspections	2b			3c			4c		
10. MICROBIOLOGY									
SR: Recommended Methods for the Microbiological Examination of Foods, American Public Health Association; Official Methods of Analysis of the Association of Official Agricultural Chemists (AOAC), (chap 15)									
a. Principles of microbiology as they pertain to food spoilage, food establishment sanitation, and control of zoonoses	A			B			C		
b. Perform microscopic examinations	1a			2b			3c		

1. TASKS, KNOWLEDGES AND STUDY REFERENCES	PROFICIENCY LEVEL, PROGRESS RECORD AND CERTIFICATION								
	2. 3 Skill Level			3. 5 Skill Level			4. 7 Skill Level		
	A AFSC/Crs	B Date OJT Started	C Date Completed & Trainee's Supervisor's Initials	A AFSC	B Date OJT Started	C Date Completed & Trainee's Supervisor's Initials	A AFSC/Crs	B Date OJT Started	C Date Completed & Trainee's Supervisor's Initials
10c. Accomplish disinfection and/or sterilization of materials and/or equipment	a			3c			4c		
d. Collect, prepare, and forward specimens for laboratory analyses; prepare and submit correspondence requesting same	a			3b			4c		
e. Perform chemical and bacteriological laboratory procedures of food samples	2a			2b			3b		
11. FOOD TECHNOLOGY									
SR: AFMs 145-1 (chap 5, 6, and 7), 163-3, 163-8; AFRs 163-2 (chap 3), 163-9, 163-11; DPSC Subsistence Inspection Manual (4155.7); Current or applicable specifications and deviation lists; Applicable DPSC clauses; Applicable military standards									
a. Common food preservation processes and storage procedures	A			B			C	NO ADVANCED COURSE	
b. Inspect preserved foods	1a			2b			4c		
c. Inspect foods for proper packaging, packing, and marking	1a			2b			4c		
d. Inspect military operational rations	1a			2b			4c		
12. FISH AND SHELLFISH INSPECTION									
SR: AFR 163-2 (sec 12-14, para 5); Current or applicable specifications and deviation lists; Applicable DPSC clauses; US Standards for Grades for Frozen Waterfoods, US Department of Commerce (USDC); Guide to Federally Inspected Fishery Products, USDC									
a. Inspect fish and shellfish for quality, wholesomeness, and contract compliance	1a			2b			4c		
b. Inspect commercial seafood establishments for sanitary standards compliance	1a/a			2b			3c		
13. PRODUCTION AND INSPECTION OF DAIRY PRODUCTS									
SR: AFM 74-15 (app A); AFRs 163-2 (chap 2 and 3), 163-7, 163-11; Current specifications, deviation lists, and other publications referenced therein; Applicable DPSC clauses, Grade A pasteurized milk ordinance; Standard Methods for the Examination of Dairy Products, American Public Health Association (chap 4, 5, 6, 7, 18, and 19)									
a. Inspect dairy processing facilities	1a/a			2b			3c		
b. Inspect dairy products	1a			2b			4c		
c. Accomplish laboratory analyses of dairy products	1a			2b			3c		
d. Interpret results of dairy product analyses	2b			3c			4c		

1. TASKS, KNOWLEDGES AND STUDY REFERENCES	PROFICIENCY LEVEL, PROGRESS RECORD AND CERTIFICATION								
	2. 3 Skill Level			3. 5 Skill Level			4. 7 Skill Level		
	A AFSC/Crs	B Date OJT Started	C Date Completed & Trainee's Supervisor's Initials	A AFSC	B Date OJT Started	C Date Completed & Trainee's Supervisor's Initials	A AFSC/Crs	B Date OJT Started	C Date Completed & Trainee's Supervisor's Initials
14. POULTRY INSPECTION .									
SR: AFR 163-2; Current specifications and deviation lists; applicable DPSC clause; Regulations Governing the Grading and Inspection cf Poultry and Edible Products and US Classes, Standards, and Grades with Respect Thereto, USDA									
a. Inspect poultry processing facilities	1a/a			2b			3c		
b. Inspect poultry and poultry products for wholesomeness and contract compliance	1a			2b			4c		
c. Perform surveillance inspections of poultry and poultry products	1a			2b			4c		
15. EGG INSPECTION									
SR: AFR 163-2; Current specifications and deviation lists; Applicable DPSC clauses: Regulations Governing the Grading of Shell Eggs and US Standards, Grades, and Weight Classes for Eggs, USDA; Regulations Governing the Grading and Inspection of Shell Eggs, USDA; Egg Grading Manual, USDA; DPSC Subsistence Inspection Manual (sec 21[illegible].2 and 213.4); List of Plants Operating Under USDA Poultry and Egg Inspection and Grading Programs, USDA									
a. Determine quality of eggs	2b			3c			4d		
b. Determine contract compliance of eggs and egg products	2a			3b			4c		
c. Accomplish surveillance inspections of eggs and egg products and make appropriate recommendations pertaining to same	2b			3c			4c	NO ADVANCED COURSE	
d. Inspect egg producing and processing facilities	1a/a			2b			3c		
16. MEAT INSPECTION									
SR: AFM 163-4; AFR 163-2; Current specifications and deviation lists; Applicable DPSC articles and clauses; Service and Regulatory Amendment #[illegible]9, USDA; DPSC Subsistence Inspection Manual; Meat Buyer's Guide to Standardized Meat Cuts, National Association of Meat Purveyors; Meat Buyer's Guide to Portion Control Meats, National Association of Meat Purveyors									
a. Scope of meat inspection services involved in military procurement	A			B			C		
b. Identify anatomical features, terminology, and practices related to meat products	1a			2b			4c		
c. Inspect and verify meat products to determine wholesomeness and contract compliance	1a			2b			4c		
d. Inspect meat processing facilities to determine sanitary compliance	1a/a			2b			3c		
e. Perform surveillance inspection of meat and meat products	1a			2b			4c		

1. TASKS, KNOWLEDGES AND STUDY REFERENCES	2. 3 Skill Level A AFSC/Crs	3 Skill Level B Date OJT Started	3 Skill Level C Date Completed & Trainee's Supervisor's Initials	3. 5 Skill Level A AFSC	5 Skill Level B Date OJT Started	5 Skill Level C Date Completed & Trainee's Supervisor's Initials	4. 7 Skill Level A AFSC/Crs	7 Skill Level B Date OJT Started	7 Skill Level C Date Completed & Trainee's Supervisor's Initials
16f. Determine procedures for evaluation and decontamination of food animals exposed to nuclear, biological, or chemical agents	-			2c			3c		
17. FRUIT AND VEGETABLE INSPECTION									
SR: AFM 145-1; AFR 163-2; Current specifications; Applicable DPSC clauses; US Standards for Fresh Fruits and Vegetables, USDA									
a. Basic botanical anatomy and physiology	A			B			B		
b. Recommend proper practices and procedures for handling and storing fruits and vegetables	1a			3b			4c		
c. Inspect fruits and vegetables for identity and condition	1a			2b			4c		
18. VETERINARY SUPPORT OF ENVIRONMENTAL HEALTH ACTIVITIES									
SR: AFMs 145-1, 161-10, 161-33, 163-8; AFRs 163-9, 163-11									
a. Organization and objectives of the Aerospace Medicine Program	B			B			C	NO ADVANCED COURSE	
b. Basic medical aspects of insect and rodent control, water purification, and sewage and waste disposal	B			C			C		
c. Accomplish routine medical evaluations of food processing, food storage, and/or food serving facilities (including flight feeding facilities and vending machine operations) and make appropriate verbal and written recommendations in regards to conditions noted	2b			3c			4d		
d. Basic principles involving the etiology and control of food-borne illnesses	A			B			C		
e. Assist in investigating outbreaks of food-borne illnesses	-			2b			3c		
f. Assist in training food handlers in medical aspects of food processing sanitation	-			3b			4c		
g. Inspect military air contract carrier food service operations	-			3c			4c		
h. Inspect military aircraft for sanitation	-			3c			4c		
19. ANIMAL SERVICE AND ZOONOTIC DISEASE CONTROL									
SR: AFMs 125-5 (chap 4, vol 10, 160-12 (chap 1), 160-37, 160-48; AFRs 125-9, 161-4, 163-4, 163-11, 168-10; AFP 163-10 (sec A & B)									

1. TASKS, KNOWLEDGES AND STUDY REFERENCES	PROFICIENCY LEVEL, PROGRESS RECORD AND CERTIFICATION 2. 3 Skill Level A AFSC/Crs	2. 3 Skill Level B Date OJT Started	2. 3 Skill Level C Date Completed & Trainee's Supervisor's Initials	3. 5 Skill Level A AFSC	3. 5 Skill Level B Date OJT Started	3. 5 Skill Level C Date Completed & Trainee's Supervisor's Initials	4. 7 Skill Level A AFSC/Crs	4. 7 Skill Level B Date OJT Started	4. 7 Skill Level C Date Completed & Trainee's Supervisor's Initials
19a. Assist in the zoonoses control program	1a/a			3c			4c		
b. Assist in the veterinary care, treatment, and management of government owned animals	1a/a			3c			4c		
c. Give subprofessional advice related to animal service activities	a			1b			3c		
d. Prepare reports and maintain records of supplies and equipment that pertain to veterinary care of privately owned animals	1a			3b			4c		
e. Prepare reports and maintain records and supplies pertaining to government owned animals	1a			3b			4c		
f. Perform laboratory procedures related to control of animal and zoonotic diseases	2b			3c			4c	NO ADVANCED COURSE	
g. Determine procedures for evaluation and decontamination of military working dogs exposed to nuclear, biological, or chemical agents	-			2c			3c		

WAPS Cycles 76B/77A (1 Jun 75-31 May 76)

SKT REVIEW REFERENCES

1. This attachment identifies review references for the Specialty Knowledge Test (SKT) under the Weighted Airman Promotion System (WAPS). The basic information needed for the SKT is covered in the Career Development Course (CDC). Other references are cited when the CDC requires supplementation to ensure currency and completeness of coverage or where no CDC exists. The attachment identifies the specific career field ladder by AFSCs and its associated Air Force Personnel Tests (AFPTs) by AFPT number.

2. Reference listings are limited to the basic reference. Amendments, revisions, and changes are considered a part of the basic reference. If publications are superseded or replaced by other publications, the latter should be regarded as part of the review references. If CDCs and other listed study references are in conflict, the later-dated reference takes precedence.

AFSCs: 90830/50/70 - Veterinary Specialist/Technician

AFPTs: 90850/70

	FOR PROMOTION TO	
REVIEW REFERENCES	E-5	E-6/E-7
*CDC 90850	X	X
AFM 74-15		
Sections 1 and 3		X
AFM 145-1, Change 1		
Chapters 2, 4, and 5		X
AFR 163-2		
Chapter 2		X
AFR 163-4		X
AFM 163-8		
Chapters 1, 2, 3, 4 and Attachment 1		X

*See index of ECI study reference material for the applicable WAPS testing cycle.

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CDC 90850

VETERINARY SERVICES SPECIALIST

(AFSC 90850)

Volume 1

The Veterinary Airman, Administration, and Statistical Procedures

Extension Course Institute

Air University

PREPARED BY
SCHOOL OF HEALTH CARE SCIENCES, USAF (ATC)
SHEPPARD AIR FORCE BASE, TEXAS

EXTENSION COURSE INSTITUTE, GUNTER AIR FORCE BASE, ALABAMA

THIS PUBLICATION HAS BEEN REVIEWED AND APPROVED BY COMPETENT PERSONNEL OF THE PREPARING COMMAND IN ACCORDANCE WITH CURRENT DIRECTIVES ON DOCTRINE, POLICY, ESSENTIALITY, PROPRIETY, AND QUALITY.

21

Preface

CONGRATULATIONS on advancing to the point in the Veterinary Career Field which qualifies you for enrollment in the CDC 90850. You are urged to be enthusiastic, persistent, and conscientious in your studies. By doing so, you will gain a greater knowledge, and more probably will qualify for AFSC upgrading. Additionally, you will be better able to compete for promotion.

This course will include information concerning AFSC advancement, administrative procedures, statistical sampling, food inspection, microbiology, food establishment sanitation, laboratory analysis of food, animal service, and support of the aerospace medicine program. In this volume you will be studying the Veterinary Service mission; airman career advancement, duties, and responsibilities; and attribute and verification inspection, including terms, records and reports, and random sampling.

As you study, you will be required to refer to certain tables; these are furnished in a separate pamphlet (Pamphlet of Sampling Plan Tables) that is included in your course materials.

Printed and bound in the back of this volume is foldout 1.

If you have questions on the accuracy or currency of the subject matter of this text, or recommendations for its improvement, send them to: School of Health Care Sciences, USAF (ATC) (MSTW/114), Sheppard AFB TX 76311.

If you have questions on course enrollment or administration, or on any of ECI's instructional aids (Your Key to Career Development, Study Reference Guides, Chapter Review Exercises, Volume Review Exercise, and Course Examination), consult your education officer, training officer, or NCO, as appropriate. If he can't answer your questions, send them to ECI, Gunter AFB, Alabama 36118, preferably on ECI Form 17, Student Request for Assistance.

This volume is valued at 18 hours (6 points).

Material in this volume is technically accurate, adequate, and current as of September 1971.

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MODIFICATIONS

Chapters 1 & 2 of this publication has (have) been deleted in adapting this material for inclusion in the "Trial Implementation of a Model System to Provide Military Curriculum Materials for Use in Vocational and Technical Education." Deleted material involves extensive use of military forms, procedures, systems, etc. and was not considered appropriate for use in vocational and technical education.

CHAPTER 3

Inspection by Attributes

ALL INDUSTRIES, especially manfacturing industries which assemble component parts into a finished product, need quality control. As an example, automobile manufacturers buy radiators, pistons, batteries, tires, nuts, bolts, washers, springs, etc., from subcontractors. The manufacturers then assemble these various parts into whole automobiles. They, like most other producers of hard goods, such as washing machines, lawn mowers, toasters, etc., have a need for some type of quality control. In the 1930s industry turned to the statisticians for the development of some valid type of quality control system. The statisticians' answer to this problem was the development of a statistical procedure for inspecting individual items and component parts. The industrial application of this inspection system was almost immediate. The system was then widely applied to the huge military procurement program of World War II. Items of ordnance, armament, clothing, and equipment are examples of military supply items inspected by statistical means.

2. Interest in statistical quality control, from a military procurement point of view, waned from the close of World War II until the Korean affair. The Department of Defense policy in 1950 decreed that statistical methods of inspection would be adopted in military procurement fields. With this policy statement, Military Standard 105, *Sampling Procedures and Tables for Inspection by Attributes*, was devised and published. Eventually statistical inspection methods were adapted to subsistence with canned goods becoming the first products to be inspected under statistical standards.

3. Since the early 1960s many specifications for all types of subsistence have been redesigned to employ statistical quality control methods. Today, inspection by attributes is employed in three types of food inspection: (1) component raw material inspection, (2) evaluation of processing methods, and (3) end item/finished product inspection. These are further explained later in this chapter. When you complete your study of this chapter, you should have the knowledge needed to perform inspections employing attribute inspection procedures. First, let's review some terms and definitions.

13. Terms and Definitions

13-1. Listed below are some terms and definitions which you must know before you can understand the information given throughout the remainder of the chapter.

Accept Number (Ac) - The number of defects or defectives an acceptable produce sample is allowed to contain for a specific size.

Acceptable Quality Level (AQL) - A nominal value (a number) expressed in terms of defects per hundred units (DHU) or percent defective that for the purpose of sampling inspection can be considered satisfactory as a process average (PA).

Attributes - The characteristics or inherent qualities of a product. *Example:* Paint is produced in many colors. White paint has the specific attribute of being white. In food inspection, attributes in the form of defects are listed in paragraph 4 of the specification for the product concerned.

Components and Raw Materials - They are the materials which are shaped, treated, or assembled to form the end items. These materials may be inspected at their source, upon receipt at the point of assembly, or at any convenient place along the assembly process where the end items are formed.

Critical Defect - A defect that is likely to result in hazardous or unsafe conditions to the user.

Defects Per Hundred Units (DHU) - One hundred times the number of defects contained in any given quantity of a product divided by the total number of units of product inspected. Expressed as a formula:

$$\frac{\text{Number of defects} \times 100}{\text{Number of units inspected}}$$

Double Sampling Plan - Sampling inspection in which the inspection of the first sample leads to a decision to accept, reject, or take a second sample. The inspection of a second sample, when required, then leads to a decision to accept or reject.

End Items - Completed products that may be inspected before or after packaging and packing for shipment or storage.

Homogeneity - Implies that a series or group of units of product are alike or similar in nature. Units of product subjected to a specific inspection should be a single type, grade, class, style, and composition, which is manufactured under essentially the same conditions and at essentially the same time.

Inspection by Attributes - The examination and classification of the characteristics of a unit of product as defective or nondefective, or counting the number of defects in the unit of product with respect to a given requirement or set of requirements.

Inspection Level - Influences directly the sample size or number of sample units to be selected. There are four special inspection levels (S–1, S–2, S–3, and S–4) and three general inspection levels (I, II, and III) for a total of seven levels.

Inspection Lot or Batch - A collection of units of product manufactured or processed under substantially the same condition from which a sample is drawn and inspected to determine compliance with acceptable criteria. The size of the lot (batch) is usually determined by an agreement between the Government and the contractor.

Limit Numbers - The total number of defects which ten consecutive lots are allowed to contain for a product to be placed on reduced inspection; the number is based on the number of sample units inspected and the AQL.

Major Defects - Any defect which is likely to reduce materially the usability of a product for its intended purpose.

MIL–STD–105 - A Department of Defense (DOD) standard which provides sampling procedures and reference tables for use in planning and conducting inspection by attributes.

Minor Defects - Any defect which is a deviation from the specification and not likely to materially reduce the usability of the product.

Multiple Sampling Plan - A type of sampling in which a decision to accept or reject an inspection lot may be reached after one or more samples from that inspection lot have been inspected. A decision will always be reached after not more than seven samples have been inspected.

Nonconformance - The failure of a unit or lot of product to conform to specified requirements for any stated quality characteristic.

Original Inspection - The first inspection of a product as distinguished from inspection of a product which has been resubmitted.

Process Average - The average percent defective or average number of defects per hundred units (DHU) of a product submitted by the supplier for original inspection.

Percent Defective - The percent defective of any given quantity of units of product is one hundred times the number of defective units of product contained therein, divided by the total number of units inspected.

$$\text{Percent defective} = \frac{100 \times \text{defectives}}{\text{number of units inspected}}$$

Process Inspection - The type of inspection where attention is devoted to such things as proper boning, trimming, cooking times and temperatures, processing methods, selection of raw ingredients, and fabrication of packaging and packing material.

Product Inspection - This type of inspection is not necessarily confined to the end product; components may be inspected at various stages of processing. The bulk of inspection attention is devoted to the finished product, and inspector recommendations are rendered upon end product compliance.

Quality Assurance Provisions (QAPs) - Specified AQL(s), inspection levels, defects, and the examinations and/or tests required on a given product, the results of which determine the product's acceptability.

Quality History - Information relative to the quality of a specific product at a particular plant during a given time.

Reject Number (Re) - The minimum number of defects based on a specific sample size which will classify a product nonconforming to specification requirements.

Resubmitted Lot - A lot which, after being found unacceptable on original inspection, is reinspected normally after being reworked by the vendor. (The vendor screens the lot removing defective units.)

Sample - One or more units of product selected at random to be inspected.

Sample Plan - A designated sample size and its accompanying criteria or requirements for acceptance or rejection. There are three types of sampling plans—*single, double,* and *multiple.*

Sample Size - The total number of units of product in the sample.

Sample Unit - A unit of product selected without regard to the quality to be a part of the sample.

Severity of Inspection - This is concerned with the amount and extent of inspection applied to a sample which is based upon the quality assurance provisions and quality history established for specific groups of characteristics. Sampling inspection plans provide for three degrees of severity of inspection: normal, tightened, and reduced.

Single Sampling Plan - A plan which consists of a single sample with associated acceptance and rejection criteria.

Unit of Product - A single item such as a can, a package, or a cut of meat which is inspected to determine the number of defects it contains. The unit of product will be specified in the specification.

Verification of Contractor Inspection - The contractor is required to accomplish his own inspection system to examine and test his product. The Government inspector periodically verifies the contractor's findings.

14. Sampling Techniques

14-1. It would be impossible for the Air Force to inspect every item it purchases and uses. The statistical inspection technique allows you to inspect a representative sample. To make sure that the selected sample is representative of the lot in question, you must plan the sampling in detail.

14-2. **Extracting Sample Plans.** To properly extract sample plans, you must know certain facts and follow definite procedures. You should accomplish the following steps in order.

(1) Determine the lot size.
(2) Obtain the inspection level.
(3) Determine the sample size code letter.
(4) Select the type of sampling plan.
(5) Establish the severity of inspection.
(6) Obtain the AQL.
(7) Determine the sample size and the acceptance and rejection number(s).

14-3. As previously explained in Section 13, Terms and Definitions, the size of the lot is usually determined by an agreement between the Government inspector's supervisor and the vendor. It will usually be the amount of product produced in one day or one shift.

14-4. *Inspection levels.* Inspection levels are listed in paragraph 4 of the specification for the product being inspected. If inspection levels are not indicated, normally level II is used. However, level S–3 should be used at destination when inspecting for condition and identity.

14-5. *Lot sizes.* To determine the sample size code letter, you must know the lot size and the inspection level. For purpose of explanation, let us assume a product has a lot size of 1,000 and the inspection level for the product is II. Now look at Table I in the Pamphlet of Sampling Plan Tables. At the top of the first, or left-hand, column note the heading "Lot or Batch Size" (we will use the term "Lot Size"). The numbers in this column denote various lot ranges. Read down this column until you come to the number 501 on the left and the number 1,200 on the right (501 to 1,200). Our lot size 1,000 falls between these two numbers. Look again at the main column headings of Table I and note that the last column is entitled "General Inspection Levels." Immediately below this are the numbers I, II, and III. These are the general inspection levels. Under each of the general inspection levels are the sample size code letters. To arrive at the sample size code letter, locate the lot size in the first column, read straight across Table I (a straightedge or ruler is recommended for this purpose) to general inspection level II. If your alignment is correct, you will intersect the letter "J" which is the sample size code letter.

14-6. You should now be able to determine sample size code letters. To make certain that you are, test your knowledge by completing the following exercise. Remember, when no inspection level is specified, use inspection level II.

Lot Size	*Inspection Level*	*Code Letter*
12,000	I	________
300	S–3	________
160		________
125,000	III	________
27	S–1	________

If your sample size code letters are not K, D, G, P, and A, reread paragraph 14-5 above and do the exercise again.

14-7. *Types of plans.* The type of product being manufactured, the volume the contractor is capable of producing, and the quality of the product being produced are the main factors that will be considered when the type of sampling plan is selected. Unless notified otherwise by your supervisor, always use a single sampling plan. Normally, the single sampling plan is used for new contractors. Although double and multiple sampling plans have certain advantages, they are rarely used because of the administrative difficulties that occur when they are employed in most subsistence contracts. Since these plans are rarely used, we will not discuss their use further during this part of your training.

14-8. *Severities of plans.* Sampling plans provide for three levels of severity inspection. They are normal, tightened, and reduced. Use normal inspection when starting your inspection on a contract unless otherwise directed.

14-9. Sampling plans for tightened inspection provide basically what the term indicates, a tighter inspection. The number of defects allowed for tightened inspection is fewer than those for normal inspection for the same sample size and AQL(s). The sample sizes for normal and tightened severity of inspection are usually the same for a given size lot. A tightened plan makes it easier to reject poor quality products.

COMPARISON BETWEEN NORMAL AND TIGHTENED INSPECTIONS:
(Single Sampling Plan - Code Letter N - AQL 1.5)

	Normal	*Tightened*
Sample Size	500	500
* Ac Number	14	12
**Re Number	15	13

14-10. Reduced inspection will be easier understood if you think of it as reducing the inspection. You are required to inspect fewer samples and, in comparison to the number of samples you inspect, the contractor is allowed more defects.

COMPARISON BETWEEN NORMAL AND REDUCED INSPECTIONS:
(Single Sampling Plan - Code Letter N - AQL 1.5)

	Normal	*Reduced*
Sample Size	500	200
Ac Number	14	7
Re Number	15	10

14-11. The following example illustrates the comparison of the three severities of inspection, using a lot size of 50,000 and an AQL of 1.5.

COMPARISON BETWEEN NORMAL, TIGHTENED, AND REDUCED
(Single Sampling Plan - Code Letter N - AQL 1.5)

	Normal	*Tightened*	*Reduced*
Sample Size	500	500	200
Ac Number	14	12	7
Re Number	15	13	10

14-12. *Obtaining the acceptable quality levels (AQLs).* The AQLs for a given product are listed in the Quality Assurance Provisions paragraph (paragraph 4) of the specification for the product concerned. The AQLs as listed therein are legal and binding on both the Government and vendor. One point to remember is that a specification may have more than one examination and test that must be performed on the product. For each examination or test, you must extract a sampling plan for each AQL. Let us assume that you are inspecting a product which has defects listed in the following categories: Major A, Major B, and Minor for an examination. Each of these categories may have a separate AQL. The terms *Major A* and *Major B*, as used here, indicate major defects. The term *Minor* indicates a minor defect. To obtain the AQL(s), you simply look them up in the Quality Assurance Provisions of the applicable specification.

14-13. *Extraction of the sampling plan.* Determining the sample size and acceptance and rejection numbers is the final step in extracting a sample plan, and is done by proper use of the data compiled thus far. To determine the code letters and sample size, let's use a lot size of 1,000 with an inspection level of II. By feeding this information into Table I, you arrived at a sample size code letter of "J." Let's continue with the sample size code letter of "J" and use the single sampling plan. Assume that the severity of inspection is normal and that you have only one AQL which is 1.5. For clarity, let's put this information in a format.

SS CODE LETTER	*TYE OF SAMPLE PLAN*	*SEVERITY OF INSP*	*AQL*
J	Single	Normal	1.5

14-14. Your next step is to *determine the sample size* and acceptance criteria. This is accomplished by feeding certain data into the proper table of Military Standard 105. Reproductions of these tables appear in the Pamphlet of Sampling Plan Tables that you received with this volume. Keep this pamphlet handy, as we will be referring to these tables frequently. To determine the correct or proper table to use, you must know two things: (1) the type of sampling plan and (2) the severity of inspection. As an example, the information given in paragraph 14-13 is that these two things are single and normal. Now, locate Table II-A in the pamphlet, and note that the title of this table, "Single Sampling Plan for Normal Inspection," indicates that it is to be used for single sampling and normal severity of inspection. This tells you that you are on the right table. One of the most common errors encountered in extracting sampling plans is using the wrong table. There are 14 pages of these tables, and each has a different purpose. The importance of using the correct table cannot be stressed too strongly. Take your time and continually check yourself when working with the tables. Don't be guilty of committing this all too common error.

14-15. Now, let's take a close look at Table II-A and determine the sample size and acceptance numbers. Reading from left to right, you will note three main headings—Sample Size Code Letter, Sample Size, and Acceptable Quality Levels. These were explained to you earlier, so no further explanation will be made here. Read down the sample size code letter column until you come to the letter "J" (the sample size code letter for the sampling plan you are extracting). Place a straightedge or ruler on the table at this point so that all of the numbers in a horizontal line with the letter "J" can be read. Next, locate your AQL of 1.5 (the twelfth AQL from the left, listed at the top of the table).

---

*Ac Number. The maximum number of defects an acceptable product is allowed to contain.

**Re Number. The minimum number of defects which constitute rejection of the product.

14-16. Immediately under the AQL, note the terms *AC (Accept)* and *Re (Reject)* with a column of figures under each. After you have located this, return to the sample size column (second from left). Read down this column (from top to bottom) to the ruler's edge and you will find your sample size of 80. To determine the acceptance numbers for your sampling plan, read down the 1.5 AQL column to the ruler's edge and if your ruler is properly aligned, you will find your acceptance numbers to be 3 under the Ac column and 4 under the Re column. Again for clarity, let's consolidate all of the data we have accumulated into a format.

Lot Size	*Insp Level*	*Samp Size Code Letter*	*Type of Samp Plan*	*Severity of Insp*	*AQL*	*Sample Size*	*Ac No*	*Re No*
1,000	*II*	*J*	*Single*	*Normal*	*1.5*	*80*	*3*	*4*

14-17. You have now extracted the necessary information for a single sampling plan. You should follow these general rules when extracting sampling plans.

(1) Extract a sampling plan for each AQL.

(2) Major defects plus minor defects equal total defects. This category is used only when there is an AQL expressed as "TOTAL."

(3) When more than one AQL is present in the same examination, the sample size of each AQL will be the same.

(4) When an arrow is encountered pointing down, use the first sampling plan below the arrow. This includes the sample size(s) as well as the accept and reject numbers.

(5) When an arrow is encountered pointing up, use the first sampling plan above the arrow. This includes the sample size(s) as well as the accept and reject numbers.

14-18. In addition to the general rules, the following rules apply for extracting a single sampling plan.

(1) Inspect all the sample units in the sample size. For example, if your sample size is 80, inspect all 80 sample units.

(2) If the number of defects found in the sample is equal to or less than the acceptance number, the lot can be considered acceptable for that particular AQL category.

(3) If the number of defects found in the sample is equal to or greater than the rejection number, the lot should be reported as nonconforming to contract requirements.

14-19. You will encounter a number of symbols as you work with the tables of sampling plans. The symbols that pertain to the specific table with which you are working are clearly defined at the bottom of the table. Become thoroughly familiar with these symbols and, as you encounter them in the body of the tables, always check their meaning before proceeding.

14-20. *Problem situation number 1.* You are preparing to inspect a product on single sampling, normal inspection. There are two AQLs—0.10 and 2.5. The size of the lot is 12,500. What are the sample sizes and acceptance numbers for each AQL if the general inspection level is I?

14-21. *Problem situation number 2.* Your supervisor has requested that you extract the following sample plans, on single sampling, normal inspection:

1. Lot size 1,150, inspection level S–4, AQL 4.0.
2. Lot size 15,000, inspection level II, AQL 0.10.
3. Lot size 15,000, inspection level I, AQL 15.

14-22. *Solution to problem situation number 1.*

Sample Size	*AQL*	*Ac No*	*Sample Size*	*AQL*	*Ac No*
125	0.10	0	125	2.5	7

Remember, though the AQLs are different, the sample sizes are the same.

14-23. *Solution to problem situation number 2.*

	Sample Size	*AQL*	*Ac No*	
1.	20	4.0	2	(*No arrows encountered*)

	Sample Size	*AQL*	*Ac No*	
2.	500	0.10	1	(Entered table at sample size of 315, but arrow directed us down)

	Sample Size	*AQL*	*Ac No*	
3.	80	15	21	(Here the arrow directs us up from code letter K and a sample size of 125)

It is unnecessary to list the reject numbers when extracting a single type and normal or tightened severities of sample plans becuase they are always one number larger than the accept number.

14-24. **Selecting Samples.** Selecting samples in the same manner for every contract or lot is not very reliable, and certainly not truly representative. This would result in inadequate protection of the Government and/or possible unfairness to the contractor. Each and every sample unit should have an equal chance of being selected from the lot with no effort being made to select a good or bad unit, or a unit from any particular portion of a lot. In inspection by attributes, a sample selection procedure known as random sampling is necessary. This method contains all of the above requirements and allows you, with the aid of a table of random numbers (see figs. 8a and 8b), to select truly representative sample units without regard to their quality. It can be used to select boxes, cartons, cases, layers from cases, and individual units from layers.

14-25. *Random sampling procedure.* In discussing the procedure to be followed, let us assume you have selected a sampling plan on a given lot of a product and are now ready to identify and select your samples. You must first know how many units are in the lot. Your next step is to number each unit in the lot mentally and physically. The number of digits to consider is determined by the lot size. With lot sizes up to 1,000 units, use three-digit numbers. To accommodate the numbers 1 through 99, precede them with zeroes (i.e., 001, 002, 003, 021, 022, 023, and 024). when you reach the number 100, drop the "0" (i.e., 100, 101, 102). When you reach 1,000, use four-digit numbers (i.e., 1,000, 1,001, 1,002). You may start numbering the lot at any point and in any direction you desire. Most inspectors number from left to right or from top to bottom. After you have accomplished this, you are ready to identify the sample units you are going to select. This is accomplished by using the table of random numbers.

14-26. *Table of random numbers.* Figures 8a and 8b show the table of random numbers. Use these figures to follow each step as we discuss the use of the table of random numbers. The numbers 0 to 9 appear in the table of random numbers an equal number of times, and are so arranged that each number has an equal opportunity of being selected. The numbers being in groups of five are of no particular significance. Use of the table can be illustrated by the following example: A sample of 5 is to be selected from a lot size of 50 which has been prenumbered 001 to 050. In selecting numbers from the table, let a pencil fall blindly at some number in the table and start at that point. Toss a coin to decide which way to go: Heads, up; tails, down.

14-27. Referring to the table of random numbers, suppose a pencil falls on column (5), line (36), and the decision is made to read down, taking only the first three digits in each group of five. You only select the numbers from 001 to 050 because there are 50 units in the lot. The sample units you would select from the prenumbered lot for this particular inspection would be:

SAMPLE NUMBER	*UNIT*	
1	040	(line 36)
2	023	(line 38)
3	016	(line 41)
4	047	(line 52)
5	009	(line 75)

14-28. When drawing the samples, units with obvious defects should not be deliberately included or excluded from the random sample.

14-29. Listed below are rules to remember when selecting inspection samples.

- Samples will be drawn at random without regard to quality.
- The manner of drawing samples must be such that it will not compromise the interest of the Government in case of dispute.
- On origin inspection, the contractor, or his authorized representative, should be present when you collect the sample units.
- The contractor should not have prior knowledge of your sampling pattern.
- Your sampling pattern should always be in writing and become a part of the history of the contract.
- Vary the sampling pattern each time sampling is conducted.
- If the lot is warehoused in such a fashion that you cannot physically reach any part, you may arrange for withdrawal of sample units by an employee of the establishment *under your personal on-the-spot supervision.*
- Samples should be properly safeguarded to prevent any possibility of their being altered, violated, or tampered with.
- When using the table of random numbers, you may start and/or read from any direction or point (i.e., top to bottom, left to right, or right to left).
- Remember, the numbers appearing in groups of five in the tables of random numbers have no particular significance to you as the inspector.

14-30. *Sampling errors.* The following are some of the common errors encountered in selecting samples.

- Samples are drawn by the contractor for the Government inspector prior to his visit.
- Samples are drawn from the wrong lot(s).
- Samples are drawn from only that portion of a lot which is available.
- Samples are drawn from morning production only to represent [illegible] full day's production.
- Samples are drawn in a crowded warehouse from only the front row of the stock.

Col. Line	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1	10480	15011	01536	02011	81647	91646	69179	14194	62590	36207	20969	99570	91291	90700
2	22368	46573	25595	85393	30995	89198	27982	53402	93965	34095	52666	19174	39615	99505
3	24130	48360	22527	97265	76393	64809	15179	24830	49340	32081	30680	19655	63348	58629
4	42167	93093	06243	61680	07856	16376	39440	53537	71341	57004	00849	74917	97758	16379
5	37570	39975	81837	16656	06121	91782	60468	81305	49684	60672	14110	06927	01263	54613
6	77921	06907	11008	42751	27756	53498	18602	70659	90655	15053	21916	81825	44394	42880
7	99562	72905	56420	69994	98872	31016	71194	18738	44013	48840	63213	21069	10634	12952
8	96301	91977	05463	07972	18876	20922	94595	56869	69014	60045	18425	84903	42508	32307
9	89579	14342	63661	10281	17453	18103	57740	84378	25331	12566	58678	44947	05585	56941
10	85475	36857	53342	53988	53060	59533	38867	62300	08158	17983	16439	11458	18593	64952
11	28918	69578	88231	33276	70997	79936	56865	05859	90106	31595	01547	85590	91610	78188
12	63553	40961	48235	03427	49626	69445	18663	72695	52180	20847	12234	90511	33703	90322
13	09429	93969	52636	92737	88974	33488	36320	17617	30015	08272	84115	27156	30613	74952
14	10365	61129	87529	85689	48237	52267	67689	93394	01511	26358	85104	20285	29975	89868
15	07119	97336	71048	08178	77233	13916	47564	81056	97735	85977	29372	74461	28551	90707
16	51085	12765	51821	51259	77452	16308	60756	92144	49442	53900	70960	63990	75601	40719
17	02368	21382	52404	60268	89368	19885	55322	44819	01188	65255	64835	44919	05944	55157
18	01011	54092	33362	94904	31273	04146	18594	29852	71585	85030	51132	01915	92747	64951
19	52162	53916	46369	58586	23216	14513	83149	98736	23495	64350	94738	17752	35156	35749
20	07056	97628	33787	09998	42698	06691	76988	13602	51851	46104	88916	19509	25625	58104
21	48663	91245	85828	14346	09172	30168	90229	04734	59193	22178	30421	61666	99904	32812
22	54164	58492	22421	74103	47070	25306	76468	26384	58151	06646	21524	15227	96909	44592
23	32639	32363	05597	24200	13363	38005	94342	28728	35806	06912	17012	64161	18296	22851
24	29334	27001	87637	87308	58731	00256	45834	15398	46557	41135	10367	07684	36188	18510
25	02488	33062	28834	07351	19731	92420	60952	61280	50001	67658	32586	86679	50720	94953
26	81525	72295	04839	96423	24878	82651	66566	14778	76797	14780	13300	87074	79666	95725
27	29676	20591	68086	26432	46901	20849	89768	81536	86645	12659	92259	57102	80428	25280
28	00742	57392	39064	66432	84673	40027	32832	61362	98947	96067	64760	64584	96096	98253
29	05366	04213	25669	26422	44407	44048	37937	63904	45766	66134	75470	66520	34693	90449
30	91921	26418	64117	94305	26766	25940	39972	22209	71500	64568	91402	42416	07844	69618
31	00582	04711	87917	77341	42206	35126	74087	99547	81817	42607	43808	76655	62028	76630
32	00725	69884	62797	56170	86324	88072	76222	36086	84637	93161	76038	65855	77919	88006
33	69011	65795	95876	55293	18988	27354	26575	08625	40801	59920	29841	80150	12777	48501
34	25976	57948	29888	88604	67917	48708	18912	82271	65424	69774	33611	54262	85963	03547
35	09763	83473	73577	12908	30883	18317	28290	35797	05998	41688	34952	37888	38917	88050
36	91567	42595	27958	30134	04024	86385	29880	99730	55536	84855	29080	09250	79656	73211
37	17955	56349	90999	49127	20044	59931	06115	20542	18059	02008	73708	83517	36103	42791
38	46503	18584	18845	49618	02304	51038	20655	58727	28168	15475	56942	53389	20562	87338
39	92157	89634	94824	78171	84610	82834	09922	25417	44137	48413	25555	21246	35509	20468
40	14577	62765	35605	81263	39667	47358	56873	56307	61607	49518	89656	20103	77490	18062
41	98427	07523	33362	64270	01638	92477	66969	98420	04880	45585	46565	04102	46880	45709
42	34914	63976	88720	82765	34476	17032	87589	40836	32427	70002	70663	88863	77775	69348
43	70060	28277	39475	46473	23219	53416	94970	25832	69975	94884	19661	72828	00102	66794
44	53976	54914	06990	67245	68350	82948	11398	42878	80287	88267	47363	46634	06541	97809
45	76072	29515	40980	07391	58745	25774	22987	80059	39911	96189	41151	14222	60697	59583
46	90725	52210	83974	29992	65831	38857	50490	83765	55657	14361	31720	57375	56228	41546
47	64364	67412	33339	31926	14883	24413	59744	92351	97473	89286	35931	04110	23726	51900
48	08962	00358	31662	25388	61642	34072	81249	35648	56891	69352	48373	45578	78547	81788

Figure 8a. Table of random numbers.

Line \ Col.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
49	95012	68379	93526	70765	10592	04542	76463	54328	02349	17247	28865	14777	62730	92277
50	15664	10493	20492	38391	91132	21999	59516	81652	27195	48223	46751	22923	32261	85653
51	16408	81899	04153	53381	79401	21438	83035	92350	36693	31238	59649	91754	72772	02338
52	18629	81953	05520	91962	04739	13092	97662	24822	94730	06496	35090	04822	86774	98289
53	73115	35101	47498	87637	99016	71060	88824	71013	18735	20286	23153	72924	35165	43040
54	57491	16703	23167	49323	45021	33132	12544	41035	80780	45393	44812	12515	98931	91202
55	30405	83946	23792	14422	15059	45799	22716	19792	09983	74353	68668	30429	70735	25499
56	16631	35006	85900	98275	32388	52390	16815	69298	82732	38480	73817	32523	41961	44437
57	96773	20206	42559	78985	05300	22164	24369	54224	35083	19687	11052	91491	60383	19746
58	38935	64202	14349	82674	66523	44133	00697	35552	35970	19124	63318	29686	03387	59846
59	31624	76384	17403	53363	44167	64486	64758	75366	76554	31601	12613	33072	60332	92325
60	78919	19474	23632	27889	47914	02584	37680	20801	72152	39339	34806	08930	85001	87820
61	03931	33309	57047	74211	63445	17361	62825	39908	05607	91284	68833	25570	38818	46920
62	74426	33278	43972	10119	89917	15665	52872	73823	73144	88662	88970	74492	51805	99378
63	09066	00903	20795	95452	92648	45454	09552	88815	16553	51125	79375	97596	16296	66092
64	42238	12426	87025	14267	20979	04508	64535	31355	86064	29472	47689	05974	52468	16834
65	16153	08002	26504	41744	81959	65642	74240	56302	00033	67107	77510	70625	28725	34191
66	21457	40742	29820	96783	29400	21840	15035	34537	33310	[illegible]	95240	15957	16572	06004
67	21581	57802	02050	89728	17937	37621	47075	42080	97403	48626	68995	43805	33186	21597
68	55612	78095	83197	33732	05810	24813	86902	60397	16489	03264	88525	42786	05269	92532
69	44657	66999	99324	51281	84463	60563	79312	93454	68876	25471	93911	25650	12682	73572
70	91340	84979	46949	81973	37949	61023	43997	15263	80644	43942	89203	71795	99533	50501
71	91227	21199	31935	27022	84067	05462	35216	14486	29891	68607	41867	14951	91696	85065
72	50001	38140	66321	19924	72163	09538	12151	06878	91903	18749	34405	56087	82790	70925
73	65390	05224	72958	28609	81406	39147	25549	48542	42627	45233	57202	94617	23772	07896
74	27504	96131	83944	41575	10573	08619	64482	73923	36152	05184	94142	25299	84387	34925
75	37169	94851	39117	89632	00959	16487	65536	49071	39782	17095	02330	73401	00275	48280
76	11508	70225	51111	38351	19444	66499	71945	05422	13442	78675	84081	66938	93654	59894
77	37449	30362	06694	54690	04052	53115	62757	95348	78662	11163	81651	50245	34971	52924
78	46515	70331	85922	38329	57015	15765	97161	17869	45349	61796	66345	81073	49106	79860
79	30986	81223	42416	58353	21532	30502	32305	86482	05174	07901	54339	58861	74818	46942
80	63798	64995	46583	09785	44160	78128	83991	42865	92520	83531	80377	35909	81250	54238
81	82486	84846	99254	67632	43218	50076	21361	64816	[illegible]	88124	41870	52689	51275	83556
82	21885	32906	92431	09060	64297	51674	64126	62570	26123	05155	59194	52799	28225	85762
83	60336	98782	07408	53458	13564	59089	26445	29789	85205	41001	12535	12133	14645	23541
84	43937	46891	24010	25560	86355	33941	25786	54990	71899	15475	95434	98227	21824	19585
85	97656	63175	89303	16275	07100	92063	21942	18611	47348	20203	18534	03862	78095	50136
86	03299	01221	05418	38982	55758	92237	26759	86367	21216	98442	08303	56613	91511	75928
87	79626	06486	03574	17668	07785	76020	79924	25651	83325	88428	85076	72811	22717	50585
88	85636	68335	47539	03129	65651	11977	02510	26113	99447	68645	34327	15152	55230	93448
89	18039	14367	61337	06177	12143	46609	32989	74014	64708	00533	35398	58408	13261	47908
90	08362	15656	60627	36478	65648	16764	53412	09013	07832	41574	17639	82163	60859	75567
91	79556	29068	04142	16268	15387	12856	66227	38358	22478	73373	88732	09443	82558	05250
92	92608	82674	27072	32534	17075	27698	98204	63863	11951	34648	88022	56148	34925	57031
93	23982	25835	40055	67006	12293	02753	14827	23235	35071	99704	37543	11601	35503	85171
94	09915	96306	05908	97901	28395	14186	00821	80703	70426	75647	76310	88717	37890	40129
95	59037	33300	26695	62247	69927	76123	50842	43834	86654	70959	79725	93872	28117	19233
96	42488	78077	69882	61657	34136	79180	97526	43092	04098	73571	80799	76536	71255	64239
97	46764	86273	63003	93017	31204	36692	40202	35275	57306	55543	53203	18098	47625	88684
98	03237	45430	55417	63282	90816	17349	88298	90183	36600	78406	06216	95787	42579	90730
99	86591	81482	52667	61582	14972	90053	89534	76036	49199	43716	97548	04379	46370	28672
100	38534	01715	94964	97288	65680	43772	37560	12918	86537	62738	19636	51132	25739	56947

Figure 8b. Table of random numbers (contd.).

14-31. Now, you have just finished reading and studying several rules for selecting samples for inspection. Let's take a break and try to work some problems where you will have to apply some of these rules.

14-32. *Problem situation number 3.* A packer offers you, the inspector, 248 cases of ground meat for verification. The completed lot has been stacked in two coolers. Several cases have been left unstrapped by the contractor for your convenience. You draw units from each open case and from the adjacent closed cases. While selecting your samples in the second cooler, you leave your previously selected samples in the first cooler. Where were you in error, and what should you have done?

14-33. *Problem situation number 4.* The inspector submits his sample of ground meat to the laboratory for verification testing of fat content. The lab report shows excess fat. The contractor claims the sample was not representative and asks for a retest of his product. By this time he has produced a new lot of 5,000 pounds of product from which the inspector draws a retest sample to settle the dispute. An error has been committed by the inspector. What is the error, and what would be the correct action?

14-34. *Solution to problem situation number 3.* You were in error when you left part of the sample unguarded, thus allowing the contractor the opportunity to tamper with the sample units. In addition you sampled cases left open by the contractor for you, which may have doubtful relationship to the offered supplies. You should have established a sample pattern to insure random sampling, disregarded cases left open by the contractor, and retained full control of sample units.

14-35. *Solution to problem situation number 4.* It is important here to realize that a sample was drawn to settle a point in dispute. The inspector should not have related the quality of the nonconforming lot to the quality of another lot. By doing this, the sample was not representative of the lot in dispute. The inspector should have drawn from the same lot as the original sample. If the lot was not available to him for sampling, he should have informed his supervisor.

14-36. **Changing Severities of Plans.** As previously stated, sampling plans provide for three levels of severity which are normal, tightened, and reduced. Inspection by attributes provides us with a method whereby we may change from one severity of inspection to another while producing a product, when certain conditions exist. This changing of severity is called *switching* or *switching procedures*. Three points to be remembered as you study switching procedures are these: (1) You should use normal severity when starting on attribute inspection unless otherwise directed. (2) You must return to normal inspection before switching from tightened to reduced, or from reduced to tightened. (3) Switching procedure determinations are applied to each class of defects that has an AQL applied to it. When there is a change in severity on classes within an examination from normal to tightened, all classes within the examination should also be switched to tightened. Likewise they all should qualify and be changed back to normal at the same time.

14-37. When normal inspection is in effect, institute tightened inspection when two out of five consecutive lots have been rejected (based upon the same AQL) [illegible] original inspection (ignoring resubmitted lots for this procedure). Table II-B in the Pamphlet of Sampling Plan Tables is the table for single sampling plans for tightened inspection.

14-38. When tightened inspection is in effect, institute normal inspection when five consecutive lots have been considered acceptable on original inspection (again, disregard resubmitted lots).

14-39. If ten consecutive lots (or such other number as may be designated by responsible authority) remain on tightened inspection, discontinue inspection and contact your supervisor for further instructions.

14-40. When normal inspection is in effect, reduced inspection can be instituted, provided all of the following conditions are satisfied.

- The preceding ten lots (or more, as indicated by the footnote to *Table VIII) have been on normal inspection and none has been rejected on original inspection.
- The total number of defects in the samples from the preceding ten lots (or more, as indicated by the footnote to Table VIII) is equal to or less than the applicable number given in Table VIII.
- Production is at a steady rate.
- Reduced inspection is considered desirable by the responsible authority. This authority is invested with DPSC and includes a Government approved Contractor Quality Control system or special procedures used for specified high value items.

14-41. When reduced inspection is in effect, institute normal inspection if any of the following occur on original inspection.

- A lot is rejected.
- Production becomes irregular or delayed.
- On single sampling, reduced inspection (see Table II-C), if the number of defects found in

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*Note: Table VIII. *Limit Numbers for Reduced Inspection*, lists the total defects allowed in ten consecutive lots or more, based on the total number of samples in the ten lots for each AQL (see footnote on Table VIII). If the defects found exceeded the numbers as listed under the AQL concerned, the product cannot be placed on reduced inspection a lot falls between the accept and reject numbers, accept the lot but return to single sampling, normal inspection starting with the next lot.

14-42. Before changing severity of inspection, remember to consider the three points we discussed in paragraph 14-36, which were:

(1) Use normal severity when starting on attribute inspection unless otherwise directed by responsible authority.

(2) Return to normal inspection before switching from tightened to reduced, or from reduced to tightened.

(3) Switching procedure can be applied to each class of defects that has an AQL applied to it. However, all classes within an examination must be on the same severity; i.e., normal, tightened, or reduced.

15. Records and Reports

15-1. There are two forms provided for our use in inspection by attributes which you should have become acquainted with during your 3-level training in the resident school. These forms are the Product Verification Record (DD Form 1714), and the Quality History Record (DD Form 745, or other suitable local form). One function of the Product Verification Record is to record the results of your inspection of a product while you are actually performing the inspection and determining the acceptability of that product. The Quality History Record provides you, your supervisor, and other concerned agencies with a ready and easy reference relative to the quality of a specific product at a particular contractor's establishment.

15-2. **Product Verification Record (DD Form 1714).** Inspection by attributes, having so many variables, necessitates that the inspection record be adapted to various methods. You, as the inspector, will find it necessary to change column headings, use the columns for other than their intended purpose, and possibly make other adjustments to the form. You may also find it necessary to use asterisks to identify footnotes and memorandums to the inspection record, and to report findings which cannot be clearly explained in other blocks. It is essential that you realize the form is flexible. Figure 9 is an example of a completed DD Form 1714. Because of the rapid changes in the DPSC manual, you should refer to subsection 208.1 of the *Defense Personnel Support Center Subsistence Inspection Manual* for detail procedures for preparing the DD Form 1714.

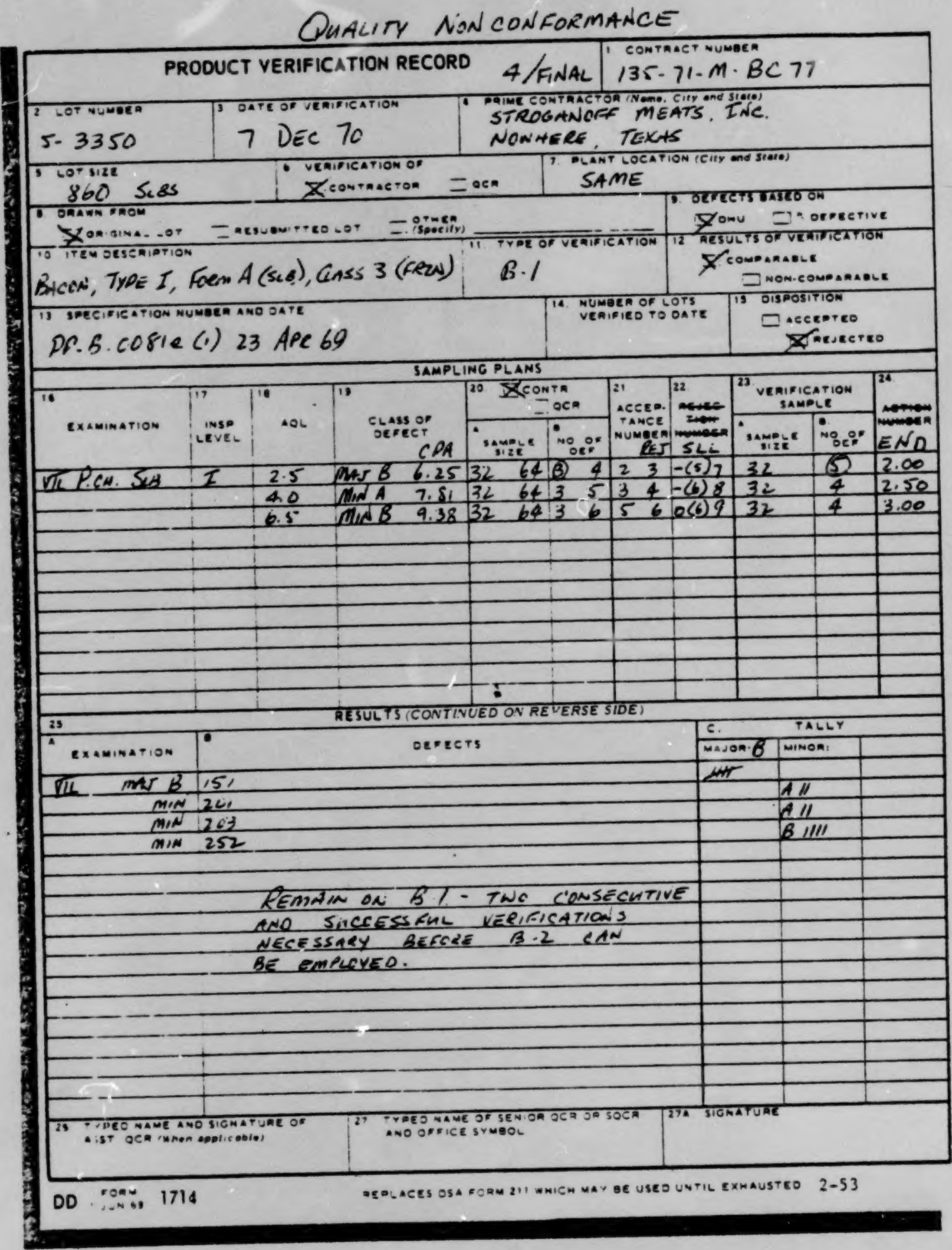
15-3. When you have the purchase instrument, you can enter certain information on the form before you go into the establishment to start the actual inspection. Of course, the actual inspection results are to be entered on the form while you are performing the inspection. This means that you must have the DD Form 1714 at hand, and tally the defects thereon as you find them. If the inspection is so messy that the form would become very blood-smeared, for example, you may have to redo the official copy later. However, *always*, and I repeat, *always*, retain and file the original work copy.

15-4. *Recording examination based on number of defects.* When the inspector finds a defect during the examination of the product, he refers to the classification of defects (CD) found in the Quality Assurance Provisions (QAPs) of the contract (usually Section 4 of the basic specification) and records the identity of the defect as described therein. If the defects are listed in the CD by number as well as by definition, only the defect number need be indicated on the form. Defects which are health hazards, or which are otherwise so serious that a single occurrence thereof is set forth in the QAPs as cause for rejection of the lot, shall be reported expeditiously to your supervisor and then to the vendor and Quality Assurance Element of the Procuring DPSC Headquarters (see subsections 209.1 and 209.3 of the DPSC Subsistence Inspection Manual). Discovery of a serious defect which is prohibited or restricted by requirements for the product, packaging, labeling, packing, or marking, but to which no AQL has been assigned or no acceptance criteria listed, is reported without delay to your supervisor and to the appropriate DPSC Headquarters with a request for guidance. Examples of defects of serious nature are "Presence of Foreign Material" or "Vacuum Less than 22 inches."

15-5. If a unit contains more than one defect, the specification or contract will normally be specific as to how the defects are to be scored; for example, the QAPs for pallets list in the classification of defects for condition of deckboards, "More than 3 deckboards with pith not firm or tight." Hence, for any one pallet, a defect is not scored until 4 or more deckboards are found to contain the condition of "pitch not firm or tight," and then only one defect is scored no matter how many deckboards over 3 for that pallet contain the flaw. If some QAPs are not specific in this matter, the following rules apply:

a. If a unit contains two or more types of defects, each type will be tallied once; for example, a can having a serious dent and missing nomenclature on the label is considered to have two defects.

b. If a unit contains two or more defects of the same type, the number of defects to be charged depends on whether or not the defects are independent of each other. If the defects



QUALITY NON CONFORMANCE

PRODUCT VERIFICATION RECORD 4/FINAL

1 CONTRACT NUMBER: 135-71-M-BC 77

2 LOT NUMBER: 5-3350

3 DATE OF VERIFICATION: 7 DEC 70

4 PRIME CONTRACTOR (Name, City and State): STROGANOFF MEATS, INC.
NOWHERE, TEXAS

5 LOT SIZE: 860 SLBS

6 VERIFICATION OF: ☒ CONTRACTOR ☐ QCR

7 PLANT LOCATION (City and State): SAME

8 DRAWN FROM: ☒ ORIGINAL LOT ☐ RESUBMITTED LOT ☐ OTHER (Specify)

9 DEFECTS BASED ON: ☒ DHU ☐ % DEFECTIVE

10 ITEM DESCRIPTION: BACON, TYPE I, FORM A (SLB), CLASS 3 (FRZN)

11 TYPE OF VERIFICATION: B-1

12 RESULTS OF VERIFICATION: ☒ COMPARABLE ☐ NON-COMPARABLE

13 SPECIFICATION NUMBER AND DATE: PP-B-C081e (1) 23 APR 69

14 NUMBER OF LOTS VERIFIED TO DATE:

15 DISPOSITION: ☐ ACCEPTED ☒ REJECTED

SAMPLING PLANS

16 EXAMINATION	17 INSP LEVEL	18 AQL	19 CLASS OF DEFECT CPA	20 ☒ CONTR ☐ QCR A SAMPLE SIZE	20 B NO OF DEF	21 ACCEPTANCE NUMBER REJ	22 ~~REJECTION NUMBER~~ SLL	23 VERIFICATION SAMPLE A SAMPLE SIZE	23 B NO OF DEF	24 ~~ACTION NUMBER~~ END
VII P.CH. SLB	I	2.5	MAJ B 6.25	32 64	③ 4	2 3	-(5) 7	32	⑤	2.00
		4.0	MIN A 7.81	32 64	3 5	3 4	-(6) 8	32	4	2.50
		6.5	MIN B 9.38	32 64	3 6	5 6	0(6) 9	32	4	3.00

RESULTS (CONTINUED ON REVERSE SIDE)

25 A EXAMINATION	B DEFECTS	C. TALLY MAJOR: B	MINOR:
VII MAJ B	151	~~||||~~	
MIN	201		A II
MIN	203		A II
MIN	252		B IIII

REMAIN ON B-1 - TWO CONSECUTIVE
AND SUCCESSFUL VERIFICATIONS
NECESSARY BEFORE B-2 CAN
BE EMPLOYED.

26 TYPED NAME AND SIGNATURE OF ASST QCR (When applicable)

27 TYPED NAME OF SENIOR QCR OR SQCR AND OFFICE SYMBOL

27A SIGNATURE

DD FORM 1 JUN 69 1714 REPLACES DSA FORM 211 WHICH MAY BE USED UNTIL EXHAUSTED 2-53

Figure 9. DD Form 1714, Product Verification Record (typical example)

are unquestionably independent (that is, each defect is obviously attributable to a different cause or operation), they should be tallied as many times as they occur. To illustrate, if a pallet stringer has two defects caused by distinctly different conditions, such as a cutout of more than 10½ inches that just runs into a knothole, two defects should be tallied. If a pallet deckboard has a nail split which is longer than the board is wide and is not supported by additional nailing, only one instance of defectiveness should be counted. The more serious defect of the two should be counted if there is a difference in classification of the defects or instances of defectiveness. Use is made of the term "instances of defectiveness" because several such described splits are required before a defect as such is scored. In instances of uncertainty, the inspector should tally defects of the same type only *once*: for example, two major dents may be caused by the same circumstances or they may have each occurred independently. Since there may be no way of knowing for certain which was the case, only *one* defect should be tallied. To cite another example, if a B-unit contains two broken crackers which were placed in the unit by the same operator, again, only *one* defect should be tallied.

15-6. *Recording examination based on number of defective units involving AQLs expressed as percent defective (% D).* Since the acceptability of the lot in this case is based on the number of defective units rather than the number of defects, it is important that units containing more than one defect be counted *only once* for each class of defects found. To assist the inspector in counting the actual number of units which are defective, adapt the following procedure:

a. The instructions of paragraphs 15-4 and 15-5 apply as to defects within a sample unit.

b. When AQLs are expressed *separately* for each class of defects (that is, when there are separate AQLs for majors, for minors, or for Major A's and Major B's), the first defect of *each class* should receive a tally "1"; thereafter, defects of the same class in the same unit should each receive a tally "0," to indicate that they are not to be included in the final summations.

c. When AQLs are expressed in terms of one class of defects, *only* one defect, the one which is most serious, should be tallied as a "1" for any given unit.

15-7. Upon completion of the examination, only defects indicated by "1" are to be counted in determining the acceptability of the lot. An explanation of tallying defects under these two systems is included in DPSC Manual 4155.18, *Subsistence Sampling Plans and Subsection 208.1, DPSC Manual 4155.5 (SIM).*

15-8. **Quality History Record (DD Form 745 or Other Suitable Local Form).** When contracts cite MIL-STD-105, your supervisor may require the maintenance of a Quality History Record. It is kept within the inspection office to provide you and your supervisor with a ready and easy reference for any information relative to the quality of a specific product at a particular contractor's establishment. Separate quality history records are maintained on each product a plant produces. For example, let us assume Bunk and Company, Omaha, Nebraska, produces frankfurters, bacon, and canned hams for the Government. In this instance, it will be necessary to maintain three quality history records—one for each product.

15-9. Before proceeding further with our discussion, it is important that you realize the quality history record is maintained for a *product*, not a contract. You may have many contract numbers recorded on a single QHR Form, but you should never have more than *one* product listed.

15-10. The QHR should be maintained on a lot-by-lot basis. As an example, after you have completed the inspection of a lot and recorded your findings, take the appropriate QHR from your files and transfer the required data onto it. Over a period of time, this form furnishes you with a running record of your inspection results, or a quality history. It also aids you in the management of switching procedures. Since it is a history of inspection results, certain other information is recorded on the form. For example, if a product had been accepted by application of a Q allowance, you should indicate this in the Remarks column. Certain information relative to Government verification of contractor inspection is also recorded on the form.

15-11. The procedure for filling out the QHR as a result of Government acceptance inspection by attributes can be found in subsection 216.2 of the DPSC manual.

15-12. **Process Average.** Process average, sometimes referred to as estimated process average, is the average number of defects per hundred units of defectives of a product found at the time of *original inspection*. This includes both accepted and rejected lots, but not reworked lots. Each class of defects (Major, Minor, etc.) is computed separately. The primary purpose of the process average is to estimate the average quality of a contractor's product based on his quality history. This becomes a permanent part of his performance record. Although a process average can be computed any time, we will compute and use it to determine comparability when verification inspection is used. A separate process average is computed for each AQL and is expressed in either defects per hundred units (DHU) or percent defective (%D). It is derived by multiplying the total number of defects or defectives in the original samples by 100, and dividing this by the total sample units in the original samples.

$$\frac{\text{SUM OF DEFECTS FOUND} \times 100 \text{ DHU}}{\text{SUM OF THE SAMPLE UNITS}} = \text{PROCESS AVERAGE (DHU)}$$

$$\frac{\text{SUM OF DEFECTIVES FOUND} \times 100}{\text{SUM OF THE SAMPLE UNITS}} = \text{PROCESS AVERAGE (\%D)}$$

15-13. *Rules to remember.* The following are rules to remember in computing process averages (rounding off). Always calculate (carry out) final process average three places beyond the decimal point, unless the third place is a 5, then calculate four places past the decimal. If the third number following the decimal point is a 1, 2, 3, or 4, drop (cancel) it.

Examples: 1.821 = 1.82; 1.822 = 1.82; 1.823 = 1.82; 1.824 = 1.82.

15-14. If the third number following the decimal point is a 6, 7, 8, or 9, raise the second number following the decimal point one number and drop the third number.

Examples: 1.826 = 1.83; 1.827 = 1.83; 1.828 = 1.83; 1.829 = 1.83.

15-15. When the third and fourth digits following the decimal point are 5 and 0 respectively, then one is added to the second digit only if it is an odd number. For example, 1.8150 rounds to 1.82.

Examples: 1.8150 = 1.82; 1.8350 = 1.84; 1.8550 = 1.86; 1.8750 = 1.88; 1.8950 = 1.90.

15-16. If the third and fourth numbers following the decimal point are 5 and 0, and an *even* number precedes the 5, drop the 5 and 0.

Examples: 1.8250 = 1.82; 1.8450 = 1.84; 1.8650 = 1.86; 1.8850 = 1.88; 1.1050 = 1.10.

15-17. If, on the other hand, the third number following the decimal point is a 5, and the fourth number is any number other than a zero, drop both and raise the second number following the decimal one number.

Examples: 1.8251 = 1.8; 1.8354 = 1.84; 1.8258 = 1.83.

15-18. A separate process average is computed for each AQL. The following is an example of computing the process average: Substituting in the process average formula, we have:

Lot Number	*Sample Size*	*AQL 1.5 Major Defects*	*AQL 4.0 Minor Defects*
1	450	25	27
2	450	10	15
3	450	10	15
4	450	10	15
5	450	13	15
6	450	3	15
7	450	7	15
8	450	4	13
9	450	0	15
10	450	0	0
TOTAL	4500	82	145

Substituting in the process average formula, we have:

$$\frac{82 \times 100}{4500} = 1.82 \text{ and } \frac{145 \times 100}{4500} = 3.22$$

82 × 100 = 8200 ÷ 4500 = 1.82 PA; 145 × 100 = 14500 ÷ 4500 = 3.22 PA.

15-19. *Exercise.* Complete the following exercises by computing the process average (PAs). If you do not arrive at the correct solution on your first attempt, review the formula and the rules, and keep trying. You may want to make up some practice problems of your own. Once you have mastered process averages, you are ready to proceed.

Lot Number	*Sample Size*	*AQL 1.5 Major Defects*	*AQL 6.5 Minor Defects*
1	325	5	8
2	325	3	15
3	325	10	7
4	325	0	12
5	325	6	0

CORRECT PROCESS AVERAGES ARE:

Major Defects	Minor Defects
PA = 1.48	PA = 2.58

Lot Number	*Sample Size*	*AQL 0.25 Major Defects*	*AQL 0.65 Minor Defects*
1	400	20	15
2	400	15	10
3	400	25	19
4	400	27	21
5	400	30	14
6	400	13	8
7	400	2	1
8	400	21	16
9	400	7	4
10	400	11	5

CORRECT PROCESS AVERAGES ARE:

Major Defects	Minor Defects
PA = 4.18	PA = 2.82

MODIFICATIONS

Chapter 4 of this publication has (have) been deleted in adapting this material for inclusion in the "Trial Implementation of a Model System to Provide Military Curriculum Materials for Use in Vocational and Technical Education." Deleted material involves extensive use of military forms, procedures, systems, etc. and was not considered appropriate for use in vocational and technical education.

38

1-2

90850 01 S01 7201

SUPLEMENTARY MATERIAL

CDC 90850

VETERINARY SERVICES SPECIALIST

Volume 1

Pamphlet of Sampling Plan Tables

Extension Course Institute

Air University

The tables in this pamphlet bear the numbers and letters assigned them in the two U.S. Government publications from which they were extracted. These tables are not numbered consecutively because only those concerning this course of study have been included. Numbering them in this fashion makes it easier for you to reference them in their respective publications. Tables I through IV and VIII were extracted from MIL-STD-105, Sampling Procedures and Tables for Inspection by Attributes. Tables A and B were extracted from the Defense Personnel Support Center (DPSC) Subsistence Inspection Manual.

TABLE I — Sample size code letters

Lot or batch size	Special inspection levels				General inspection levels		
	S-1	S-2	S-3	S-4	I	II	III
2 to 8	A	A	A	A	A	A	B
9 to 15	A	A	A	A	A	B	C
16 to 25	A	A	B	B	B	C	D
26 to 50	A	B	B	C	C	D	E
51 to 90	B	B	C	C	C	E	F
91 to 150	B	B	C	D	D	F	G
151 to 280	B	C	D	E	E	G	H
281 to 500	B	C	D	E	F	H	J
501 to 1200	C	C	E	F	G	J	K
1201 to 3200	C	D	E	G	H	K	L
3201 to 10000	C	D	F	G	J	L	M
10001 to 35000	C	D	F	H	K	M	N
35001 to 150000	D	E	G	J	L	N	P
150001 to 500000	D	E	G	J	M	P	Q
500001 and over	D	E	H	K	N	Q	R

SINGLE NORMAL

2

TABLE II-A—Single sampling plans for normal inspection (Master table)

Sample size code letter	Sample size	Acceptable Quality Levels (normal inspection)																																																			
		0.010		0.015		0.025		0.040		0.065		0.10		0.15		0.25		0.40		0.65		1.0		1.5		2.5		4.0		6.5		10		15		25		40		65		100		150		250		400		650		1000	
		Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re
A	2	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		0	1	⇩		⇩		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	30	31
B	3	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		0	1	⇧		⇩		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	30	31	44	45
C	5	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		0	1	⇧		⇩		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	30	31	44	45	⇧	
D	8	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		0	1	⇧		⇩		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	30	31	44	45	⇧		⇧	
E	13	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		0	1	⇧		⇩		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	30	31	44	45	⇧		⇧		⇧	
F	20	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		0	1	⇧		⇩		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	⇧		⇧		⇧		⇧		⇧		⇧	
G	32	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		0	1	⇧		⇩		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	⇧		⇧		⇧		⇧		⇧		⇧		⇧	
H	50	⇩		⇩		⇩		⇩		⇩		⇩		⇩		0	1	⇧		⇩		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
J	80	⇩		⇩		⇩		⇩		⇩		⇩		0	1	⇧		⇩		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
K	125	⇩		⇩		⇩		⇩		⇩		0	1	⇧		⇩		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
L	200	⇩		⇩		⇩		⇩		0	1	⇧		⇩		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
M	315	⇩		⇩		⇩		0	1	⇧		⇩		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
N	500	⇩		⇩		0	1	⇧		⇩		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
P	800	⇩		0	1	⇧		⇩		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
Q	1250	0	1	⇧		⇩		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
R	2000	⇧		⇧		1	2	2	3	3	4	5	6	7	8	10	11	14	15	21	22	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	

⇩ = Use first sampling plan below arrow. If sample size equals, or exceeds, lot or batch size, do 100 percent inspection.

⇧ = Use first sampling plan above arrow.

Ac = Acceptance number

Re = Rejection number.

TABLE II-B — Single sampling plans for tightened inspection (Master table)

Sample size code letter	Sample size	Acceptable Quality Levels (tightened inspection)																																																			
		0.010		0.015		0.025		0.040		0.065		0.10		0.15		0.25		0.40		0.65		1.0		1.5		2.5		4.0		6.5		10		15		25		40		65		100		150		250		400		650		1000	
		Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re
A	2	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		1	2	2	3	3	4	5	6	8	9	12	13	18	19	27	28
B	3	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		0	1	⇩		⇩		1	2	2	3	3	4	5	6	8	9	12	13	18	19	27	28	41	42
C	5	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		0	1	⇩		⇩		1	2	2	3	3	4	5	6	8	9	12	13	18	19	27	28	41	42	⇧	
D	8	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		0	1	⇩		⇩		1	2	2	3	3	4	5	6	8	9	12	13	18	19	27	28	41	42	⇧		⇧	
E	13	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		0	1	⇩		⇩		1	2	2	3	3	4	5	6	8	9	12	13	18	19	27	28	41	42	⇧		⇧		⇧	
F	20	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		0	1	⇩		⇩		1	2	2	3	3	4	5	6	8	9	12	13	18	19	⇧		⇧		⇧		⇧		⇧		⇧	
G	32	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		0	1	⇩		⇩		1	2	2	3	3	4	5	6	8	9	12	13	18	19	⇧		⇧		⇧		⇧		⇧		⇧		⇧	
H	50	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		0	1	⇩		⇩		1	2	2	3	3	4	5	6	8	9	12	13	18	19	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
J	80	⇩		⇩		⇩		⇩		⇩		⇩		⇩		0	1	⇩		⇩		1	2	2	3	3	4	5	6	8	9	12	13	18	19	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
K	125	⇩		⇩		⇩		⇩		⇩		⇩		0	1	⇩		⇩		1	2	2	3	3	4	5	6	8	9	12	13	18	19	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
L	200	⇩		⇩		⇩		⇩		⇩		0	1	⇩		⇩		1	2	2	3	3	4	5	6	8	9	12	13	18	19	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
M	315	⇩		⇩		⇩		⇩		0	1	⇩		⇩		1	2	2	3	3	4	5	6	8	9	12	13	18	19	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
N	500	⇩		⇩		⇩		0	1	⇩		⇩		1	2	2	3	3	4	5	6	8	9	12	13	18	19	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
P	800	⇩		⇩		0	1	⇩		⇩		1	2	2	3	3	4	5	6	8	9	12	13	18	19	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
Q	1250	⇩		0	1	⇩		⇩		1	2	2	3	3	4	5	6	8	9	12	13	18	19	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
R	2000	0	1	⇧		⇩		1	2	2	3	3	4	5	6	8	9	12	13	18	19	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
S	3150					1	2																																																

⇩ = Use first sampling plan below arrow. If sample size equals or exceeds lot or batch size, do 100 percent inspection.
⇧ = Use first sampling plan above arrow.
Ac = Acceptance number.
Re = Rejection number.

SINGLE
REDUCED

TABLE II-C—Single sampling plans for reduced inspection (Master table)

Sample size code letter	Sample size	Acceptable Quality Levels (reduced inspection)†																									
		0.010	0.015	0.025	0.040	0.065	0.10	0.15	0.25	0.40	0.65	1.0	1.5	2.5	4.0	6.5	10	15	25	40	65	100	150	250	400	650	1000
		Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re
A	2	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	0 1	⇩	⇩	1 2	2 3	3 4	5 6	7 8	10 11	14 15	21 22	30 31
B	2														0 1	⇧		0 2	1 3	2 4	3 5	5 6	7 8	10 11	14 15	21 22	30 31
C	2													0 1	⇧	⇩	0 2	1 3	1 4	2 5	3 6	5 8	7 10	10 13	14 17	21 24	⇧
D	3												0 1	⇧	⇩	0 2	1 3	1 4	2 5	3 6	5 8	7 10	10 13	14 17	21 24	⇧	
E	5											0 1	⇧	⇩	0 2	1 3	1 4	2 5	3 6	5 8	7 10	10 13	14 17	21 24	⇧		
F	8										0 1	⇧	⇩	0 2	1 3	1 4	2 5	3 6	5 8	7 10	10 13	⇧	⇧	⇧			
G	13									0 1	⇧	⇩	0 2	1 3	1 4	2 5	3 6	5 8	7 10	10 13	⇧						
H	20								0 1	⇧	⇩	0 2	1 3	1 4	2 5	3 6	5 8	7 10	10 13	⇧							
J	32							0 1	⇧	⇩	0 2	1 3	1 4	2 5	3 6	5 8	7 10	10 13	⇧								
K	50						0 1	⇧	⇩	0 2	1 3	1 4	2 5	3 6	5 8	7 10	10 13	⇧									
L	80					0 1	⇧	⇩	0 2	1 3	1 4	2 5	3 6	5 8	7 10	10 13	⇧										
M	125				0 1	⇧	⇩	0 2	1 3	1 4	2 5	3 6	5 8	7 10	10 13	⇧											
N	200			0 1	⇧	⇩	0 2	1 3	1 4	2 5	3 6	5 8	7 10	10 13	⇧												
P	315		0 1	⇧	⇩	0 2	1 3	1 4	2 5	3 6	5 8	7 10	10 13	⇧													
Q	500	0 1	⇧	⇩	0 2	1 3	1 4	2 5	3 6	5 8	7 10	10 13	⇧														
R	800	⇧		0 2	1 3	1 4	2 5	3 6	5 8	7 10	10 13	⇧															

⇩ = Use first sampling plan below arrow. If sample size equals or exceeds lot or batch size, do 100 percent inspection.
⇧ = Use first sampling plan above arrow.
Ac = Acceptance number.
Re = Rejection number.
† = If the acceptance number has been exceeded, but the rejection number has not been reached, accept the lot, but reinstate normal inspection (see 10.1.4).

TABLE III-A—Double sampling plans for normal inspection (Master table)

Sample size code letter	Sample	Sample size	Cumulative sample size	Acceptable Quality Levels (normal inspection)																																																			
				0.010		0.015		0.025		0.040		0.065		0.10		0.15		0.25		0.40		0.65		1.0		1.5		2.5		4.0		6.5		10		15		25		40		65		100		150		250		400		650		1000	
				Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re
A				⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		*		⇩		⇩		*		*		*		*		*		*		*		*		*	
B	First	2	2	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		*		⇧		⇩		0	2	0	3	1	4	2	5	3	7	5	9	7	11	11	16	17	22	25	31
	Second	2	4																															1	2	3	4	4	5	6	7	8	9	12	13	18	19	26	27	37	38	56	57
C	First	3	3	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		*		⇧		⇩		0	2	0	3	1	4	2	5	3	7	5	9	7	11	11	16	17	22	25	31	⇧	
	Second	3	6																													1	2	3	4	4	5	6	7	8	9	12	13	18	19	26	27	37	38	56	57		
D	First	5	5	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		*		⇧		⇩		0	2	0	3	1	4	2	5	3	7	5	9	7	11	11	16	17	22	25	31	⇧		⇧	
	Second	5	10																													1	2	3	4	4	5	6	7	8	9	12	13	18	19	26	27	37	38	56	57				
E	First	8	8	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		*		⇧		⇩		0	2	0	3	1	4	2	5	3	7	5	9	7	11	11	16	17	22	25	31	⇧		⇧		⇧	
	Second	8	16																											1	2	3	4	4	5	6	7	8	9	12	13	18	19	26	27	37	38	56	57						
F	First	13	13	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		*		⇧		⇩		0	2	0	3	1	4	2	5	3	7	5	9	7	11	11	16	⇧		⇧		⇧		⇧		⇧		⇧	
	Second	13	26																									1	2	3	4	4	5	6	7	8	9	12	13	18	19	26	27												
G	First	20	20	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		*		⇧		⇩		0	2	0	3	1	4	2	5	3	7	5	9	7	11	11	16	⇧		⇧		⇧		⇧		⇧		⇧		⇧	
	Second	20	40																							1	2	3	4	4	5	6	7	8	9	12	13	18	19	26	27														
H	First	32	32	⇩		⇩		⇩		⇩		⇩		⇩		⇩		*		⇧		⇩		0	2	0	3	1	4	2	5	3	7	5	9	7	11	11	16	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
	Second	32	64																					1	2	3	4	4	5	6	7	8	9	12	13	18	19	26	27																
J	First	50	50	⇩		⇩		⇩		⇩		⇩		⇩		*		⇧		⇩		0	2	0	3	1	4	2	5	3	7	5	9	7	11	11	16	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
	Second	50	100																			1	2	3	4	4	5	6	7	8	9	12	13	18	19	26	27																		
K	First	80	80	⇩		⇩		⇩		⇩		⇩		*		⇧		⇩		0	2	0	3	1	4	2	5	3	7	5	9	7	11	11	16	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
	Second	80	160																	1	2	3	4	4	5	6	7	8	9	12	13	18	19	26	27																				
L	First	125	125	⇩		⇩		⇩		⇩		*		⇧		⇩		0	2	0	3	1	4	2	5	3	7	5	9	7	11	11	16	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
	Second	125	250															1	2	3	4	4	5	6	7	8	9	12	13	18	19	26	27																						
M	First	200	200	⇩		⇩		⇩		*		⇧		⇩		0	2	0	3	1	4	2	5	3	7	5	9	7	11	11	16	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
	Second	200	400													1	2	3	4	4	5	6	7	8	9	12	13	18	19	26	27																								
N	First	315	315	⇩		⇩		*		⇧		⇩		0	2	0	3	1	4	2	5	3	7	5	9	7	11	11	16	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
	Second	315	630											1	2	3	4	4	5	6	7	8	9	12	13	18	19	26	27																										
P	First	500	500	⇩		*		⇧		⇩		0	2	0	3	1	4	2	5	3	7	5	9	7	11	11	16	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
	Second	500	1000									1	2	3	4	4	5	6	7	8	9	12	13	18	19	26	27																												
Q	First	800	800	*		⇧		⇩		0	2	0	3	1	4	2	5	3	7	5	9	7	11	11	16	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
	Second	800	1600							1	2	3	4	4	5	6	7	8	9	12	13	18	19	26	27																														
R	First	1250	1250	⇧		⇧		0	2	0	3	1	4	2	5	3	7	5	9	7	11	11	16	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
	Second	1250	2500					1	2	3	4	4	5	6	7	8	9	12	13	18	19	26	27																																

⇩ = Use first sampling plan below arrow. If sample size equals or exceeds lot or batch size, do 100 percent inspection.
⇧ = Use first sampling plan above arrow.
Ac = Acceptance number
Re = Rejection number
* = Use corresponding single sampling plan (or alternatively, use double sampling plan below, where available).

TABLE III-B — Double sampling plans for tightened inspection (Master table)

Sample size code letter	Sample	Sample size	Cumulative sample size	Acceptable Quality Levels (tightened inspection)																									
				0.010	0.015	0.025	0.040	0.065	0.10	0.15	0.25	0.40	0.65	1.0	1.5	2.5	4.0	6.5	10	15	25	40	65	100	150	250	400	650	1000
				Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re
A				⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	*	*	*	*	*	*	*	*
B	First	2	2	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	*	⇩	⇩	0 2	0 3	1 4	2 5	3 7	6 10	9 14	15 20	23 29
	Second	2	4																		1 2	3 4	4 5	6 7	11 12	15 16	23 24	34 35	52 53
C	First	3	3	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	*	⇩	⇩	0 2	0 3	1 4	2 5	3 7	6 10	9 14	15 20	23 29	⇧
	Second	3	6															1 2	3 4	4 5	6 7	11 12	15 16	23 24	34 35	52 53	
D	First	5	5	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	*	⇩	⇩	0 2	0 3	1 4	2 5	3 7	6 10	9 14	15 20	23 29	⇧	⇧
	Second	5	10																1 2	3 4	4 5	6 7	11 12	15 16	23 24	34 35	52 53		
E	First	8	8	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	*	⇩	⇩	0 2	0 3	1 4	2 5	3 7	6 10	9 14	15 20	23 29	⇧	⇧	⇧
	Second	8	16													1 2	3 4	4 5	6 7	11 12	15 16	23 24	34 35	52 53			
F	First	13	13	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	*	⇩	⇩	0 2	0 3	1 4	2 5	3 7	6 10	9 14	⇧	⇧	⇧	⇧	⇧	⇧
	Second	13	26												1 2	3 4	4 5	6 7	11 12	15 16	23 24						
G	First	20	20	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	*	⇩	⇩	0 2	0 3	1 4	2 5	3 7	6 10	9 14	⇧	⇧	⇧	⇧	⇧	⇧	⇧
	Second	20	40												1 2	3 4	4 5	6 7	11 12	15 16	23 24							
H	First	32	32	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	*	⇩	⇩	0 2	0 3	1 4	2 5	3 7	6 10	9 14	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧
	Second	32	64										1 2	3 4	4 5	6 7	11 12	15 16	23 24								
J	First	50	50	⇩	⇩	⇩	⇩	⇩	⇩	⇩	*	⇩	⇩	0 2	0 3	1 4	2 5	3 7	6 10	9 14	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧
	Second	50	100									1 2	3 4	4 5	6 7	11 12	15 16	23 24									
K	First	80	80	⇩	⇩	⇩	⇩	⇩	⇩	*	⇩	⇩	0 2	0 3	1 4	2 5	3 7	6 10	9 14	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧
	Second	80	160										1 2	3 4	4 5	6 7	11 12	15 16	23 24										
L	First	125	125	⇩	⇩	⇩	⇩	⇩	*	⇩	⇩	0 2	0 3	1 4	2 5	3 7	6 10	9 14	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧
	Second	125	250									1 2	3 4	4 5	6 7	11 12	15 16	23 24											
M	First	200	200	⇩	⇩	⇩	⇩	*	⇩	⇩	0 2	0 3	1 4	2 5	3 7	6 10	9 14	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧
	Second	200	400								1 2	3 4	4 5	6 7	11 12	15 16	23 24												
N	First	315	315	⇩	⇩	⇩	*	⇩	⇩	0 2	0 3	1 4	2 5	3 7	6 10	9 14	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧
	Second	315	630							1 2	3 4	4 5	6 7	11 12	15 16	23 24													
P	First	500	500	⇩	⇩	*	⇩	⇩	0 2	0 3	1 4	2 5	3 7	6 10	9 14	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧
	Second	500	1000						1 2	3 4	4 5	6 7	11 12	15 16	23 24														
Q	First	800	800	⇩	*	⇩	⇩	0 2	0 3	1 4	2 5	3 7	6 10	9 14	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧
	Second	800	1600,					1 2	3 4	4 5	6 7	11 12	15 16	23 24															
R	First	1250	1250	*	⇧	⇩	0 2	0 3	1 4	2 5	3 7	6 10	9 14	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧	⇧
	Second	1250	2500				1 2	3 4	4 5	6 7	11 12	15 16	23 24																
S	First	2000	2000			0 2																							
	Second	2000	4000			1 2																							

⇩ = Use first sampling plan below arrow. If sample size equals or exceeds lot or batch size, do 100 percent inspection.

⇧ = Use first sampling plan above arrow.

Ac = Acceptance number

Re = Rejection number

* = Use corresponding single sampling plan (or, alternatively, use double sampling plan below, where available).

TABLE III-C — *Double sampling plans for reduced inspection (Master table)*

Sample size code letter	Sample	Sample size	Cumulative sample size	Acceptable Quality Levels (reduced inspection)†																									
				0.010	0.015	0.025	0.040	0.065	0.10	0.15	0.25	0.40	0.65	1.0	1.5	2.5	4.0	6.5	10	15	25	40	65	100	150	250	400	650	1000
				Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re	Ac Re
A				⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	⇩	•	⇩	⇩	•	•	•	•	•	•	•	•	•
B																	•	⇧		•	•	•	•	•	•	•	•	•	•
C																•	⇧	⇩	•	•	•	•	•	•	•	•	•	•	⇧
D	First	2	2												•	⇧	⇩	0 2	0 3	0 4	0 4	1 5	2 7	3 8	5 10	7 12	11 17	⇧	
	Second	2	4															0 2	0 4	1 5	3 6	4 7	6 9	8 12	12 16	18 22	26 30		
E	First	3	3											•	⇧	⇩	0 2	0 3	0 4	0 4	1 5	2 7	3 8	5 10	7 12	11 17	⇧		
	Second	3	6														0 2	0 4	1 5	3 6	4 7	6 9	8 12	12 16	18 22	26 30			
F	First	5	5										•	⇧	⇩	0 2	0 3	0 4	0 4	1 5	2 7	3 8	5 10	⇧	⇧	⇧			
	Second	5	10													0 2	0 4	1 5	3 6	4 7	6 9	8 12	12 16						
G	First	8	8									•	⇧	⇩	0 2	0 3	0 4	0 4	1 5	2 7	3 8	5 10	⇧						
	Second	8	16												0 2	0 4	1 5	3 6	4 7	6 9	8 12	12 16							
H	First	13	13								•	⇧	⇩	0 2	0 3	0 4	0 4	1 5	2 7	3 8	5 10	⇧							
	Second	13	26											0 2	0 4	1 5	3 6	4 7	6 9	8 12	12 16								
J	First	20	20							•	⇧	⇩	0 2	0 3	0 4	0 4	1 5	2 7	3 8	5 10	⇧								
	Second	20	40										0 2	0 4	1 5	3 6	4 7	6 9	8 12	12 16									
K	First	32	32						•	⇧	⇩	0 2	0 3	0 4	0 4	1 5	2 7	3 8	5 10	⇧									
	Second	32	64									0 2	0 4	1 5	3 6	4 7	6 9	8 12	12 16										
L	First	50	50					•	⇧	⇩	0 2	0 3	0 4	0 4	1 5	2 7	3 8	5 10	⇧										
	Second	50	100								0 2	0 4	1 5	3 6	4 7	6 9	8 12	12 16											
M	First	80	80				•	⇧	⇩	0 2	0 3	0 4	0 4	1 5	2 7	3 8	5 10	⇧											
	Second	80	160							0 2	0 4	1 5	3 6	4 7	6 9	8 12	12 16												
N	First	125	125			•	⇧	⇩	0 2	0 3	0 4	0 4	1 5	2 7	3 8	5 10	⇧												
	Second	125	250						0 2	0 4	1 5	3 6	4 7	6 9	8 12	12 16													
P	First	200	200		•	⇧	⇩	0 2	0 3	0 4	0 4	1 5	2 7	3 8	5 10	⇧													
	Second	200	400					0 2	0 4	1 5	3 6	4 7	6 9	8 12	12 16														
Q	First	315	315	•	⇧	⇩	0 2	0 3	0 4	0 4	1 5	2 7	3 8	5 10	⇧														
	Second	315	630				0 2	0 4	1 5	3 6	4 7	6 9	8 12	12 16															
R	First	500	500	⇧		0 2	0 3	0 4	0 4	1 5	2 7	3 8	5 10	⇧															
	Second	500	1000			0 2	0 4	1 5	3 6	4 7	6 9	8 12	12 16																

⇩ = Use first sampling plan below arrow. If sample size equals or exceeds lot or batch size, do 100 percent inspection.
⇧ = Use first sampling plan above arrow.
Ac = Acceptance number.
Re = Rejection number.
• = Use corresponding single sampling plan (or alternatively, use double sampling plan below, when available.)
† = If, after the second sample, the acceptance number has been exceeded, but the rejection number has not been reached, accept the lot, but reinstate normal inspection (see 10.14).

7

DOUBLE
REDUCED

TABLE IV-A—Multiple sampling plans for normal inspection (Master table)

Sample size code letter	Sample	Sample size	Cumulative sample size	Acceptable Quality Levels (normal inspection)																																																		
				0.010		0.015		0.025		0.040		0.065		0.10		0.15		0.25		0.40		0.65		1.0		1.5		2.5		4.0		6.5		10		15		25		40		65		100		150		250		400		650		1000	
				Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re
A				↓		↓		↓		↓		↓		↓		↓		↓		↓		↓		↓		↓		↓		↓		*		↓		↓		*		*		*		*		*		*		*		*		*	
B				↓		↓		↓		↓		↓		↓		↓		↓		↓		↓		↓		↓		↓		*		↑		↓		++		++		++		++		++		++		++		++		++		++	
C				↓		↓		↓		↓		↓		↓		↓		↓		↓		↓		↓		↓		*		↑		↓		++		++		++		++		++		++		++		++		++		++		↑	
D	First	2	2	↓		↓		↓		↓		↓		↓		↓		↓		↓		↓		↓		*		↑		↓		#	2	#	2	#	3	#	4	0	4	0	5	1	7	2	9	4	12	6	16	↑		↑	
	Second	2	4																													#	2	0	3	0	3	1	5	1	6	3	8	4	10	7	14	11	19	17	27				
	Third	2	6																													0	2	0	3	1	4	2	6	3	8	6	10	8	13	13	19	19	27	29	39				
	Fourth	2	8																													0	3	1	4	2	5	3	7	5	10	8	13	12	17	19	25	27	34	40	49				
	Fifth	2	10																													1	3	2	4	3	6	5	8	7	11	11	15	17	20	25	29	36	40	53	58				
	Sixth	2	12																													1	3	3	5	4	6	7	9	10	12	14	17	21	23	31	33	45	47	65	68				
	Seventh	2	14																													2	3	4	5	6	7	9	10	13	14	18	19	25	26	37	38	53	54	77	78				
E	First	3	3	↓		↓		↓		↓		↓		↓		↓		↓		↓		↓		*		↑		↓		#	2	#	2	#	3	#	4	0	4	0	5	1	7	2	9	4	12	6	16	↑		↑		↑	
	Second	3	6																											#	2	0	3	0	3	1	5	1	6	3	8	4	10	7	14	11	19	17	27						
	Third	3	9																											0	2	0	3	1	4	2	6	3	8	6	10	8	13	13	19	19	27	29	39						
	Fourth	3	12																											0	3	1	4	2	5	3	7	5	10	8	13	12	17	19	25	27	34	40	49						
	Fifth	3	15																											1	3	2	4	3	6	5	8	7	11	11	15	17	20	25	29	36	40	53	58						
	Sixth	3	18																											1	3	3	5	4	6	7	9	10	12	14	17	21	23	31	33	45	47	65	68						
	Seventh	3	21																											2	3	4	5	6	7	9	10	13	14	18	19	25	26	37	38	53	54	77	78						
F	First	5	5	↓		↓		↓		↓		↓		↓		↓		↓		↓		*		↑		↓		#	2	#	2	#	3	#	4	0	4	0	5	1	7	2	9	↑		↑		↑		↑		↑		↑	
	Second	5	10																									#	2	0	3	0	3	1	5	1	6	3	8	4	10	7	14												
	Third	5	15																									0	2	0	3	1	4	2	6	3	8	6	10	8	13	13	19												
	Fourth	5	20																									0	3	1	4	2	5	3	7	5	10	8	13	12	17	19	25												
	Fifth	5	25																									1	3	2	4	3	6	5	8	7	11	11	15	17	20	25	29												
	Sixth	5	30																									1	3	3	5	4	6	7	9	10	12	14	17	21	23	31	33												
	Seventh	5	35																									2	3	4	5	6	7	9	10	13	14	18	19	25	26	37	38												
G	First	8	8	↓		↓		↓		↓		↓		↓		↓		↓		*		↑		↓		#	2	#	2	#	3	#	4	0	4	0	5	1	7	2	9	↑		↑		↑		↑		↑		↑		↑	
	Second	8	16																							#	2	0	3	0	3	1	5	1	6	3	8	4	10	7	14														
	Third	8	24																							0	2	0	3	1	4	2	6	3	8	6	10	8	13	13	19														
	Fourth	8	32																							0	3	1	4	2	5	3	7	5	10	8	13	12	17	19	25														
	Fifth	8	40																							1	3	2	4	3	6	5	8	7	11	11	15	17	20	25	29														
	Sixth	8	48																							1	3	3	5	4	6	7	9	10	12	14	17	21	23	31	33														
	Seventh	8	56																							2	3	4	5	6	7	9	10	13	14	18	19	25	26	37	38														
H	First	13	13	↓		↓		↓		↓		↓		↓		↓		*		↑		↓		#	2	#	2	#	3	#	4	0	4	0	5	1	7	2	9	↑		↑		↑		↑		↑		↑		↑		↑	
	Second	13	26																					#	2	0	3	0	3	1	5	1	6	3	8	4	10	7	14																
	Third	13	39																					0	2	0	3	1	4	2	6	3	8	6	10	8	13	13	19																
	Fourth	13	52																					0	3	1	4	2	5	3	7	5	10	8	13	12	17	19	25																
	Fifth	13	65																					1	3	2	4	3	6	5	8	7	11	11	15	17	20	25	29																
	Sixth	13	78																					1	3	3	5	4	6	7	9	10	12	14	17	21	23	31	33																
	Seventh	13	91																					2	3	4	5	6	7	9	10	13	14	18	19	25	26	37	38																
J	First	20	20	↓		↓		↓		↓		↓		↓		*		↑		↓		#	2	#	2	#	3	#	4	0	4	0	5	1	7	2	9	↑		↑		↑		↑		↑		↑		↑		↑		↑	
	Second	20	40																			#	2	0	3	0	3	1	5	1	6	3	8	4	10	7	14																		
	Third	20	60																			0	2	0	3	1	4	2	6	3	8	6	10	8	13	13	19																		
	Fourth	20	80																			0	3	1	4	2	5	3	7	5	10	8	13	12	17	19	25																		
	Fifth	20	100																			1	3	2	4	3	6	5	8	7	11	11	15	17	20	25	29																		
	Sixth	20	120																			1	3	3	5	4	6	7	9	10	12	14	17	21	23	31	33																		
	Seventh	20	140																			2	3	4	5	6	7	9	10	13	14	18	19	25	26	37	38																		

↓ = Use first sampling plan below arrow (refer to continuation of table on following page, when necessary). If sample size equals or exceeds lot or batch size, do 100 percent inspection.
↑ = Use first sampling plan above arrow.
Ac = Acceptance number.
Re = Rejection number.
* = Use corresponding single sampling plan (or alternatively, use multiple sampling plan below, where available).
++ = Use corresponding double sampling plan (or alternatively, use multiple sampling plan below, where available).
# = Acceptance not permitted at this sample size.

TABLE IV-A — *Multiple sampling plans for normal inspection (Master table)*
(Continued)

Sample size code letter	Sample	Sample size	Cumulative sample size	Acceptable Quality Levels (normal inspection)																																																			
				0.010		0.015		0.025		0.040		0.065		0.10		0.15		0.25		0.40		0.65		1.0		1.5		2.5		4.0		6.5		10		15		25		40		65		100		150		250		400		650		1000	
				Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re
K	First	32	32	↓		↓		↓		↓		↓		*		↑		↓		#	2	#	2	#	3	#	4	0	4	0	5	1	7	2	9	↑		↑		↑		↑		↑		↑		↑		↑		↑		↑	
	Second	32	64																	#	2	0	3	0	3	1	5	1	6	3	8	4	10	7	14																				
	Third	32	96																	0	2	0	3	1	4	2	6	3	8	6	10	8	13	13	19																				
	Fourth	32	128																	0	3	1	4	2	5	3	7	5	10	8	13	12	17	19	25																				
	Fifth	32	160																	1	3	2	4	3	6	5	8	7	11	11	15	17	20	25	29																				
	Sixth	32	192																	1	3	3	5	4	6	7	9	10	12	14	17	21	23	31	33																				
	Seventh	32	224																	2	3	4	5	6	7	9	10	13	14	18	19	25	26	37	38																				
L	First	50	50	↓		↓		↓		↓		*		↑		↓		#	2	#	2	#	3	#	4	0	4	0	5	1	7	2	9	↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑	
	Second	50	100															#	2	0	3	0	3	1	5	1	6	3	8	4	10	7	14																						
	Third	50	150															0	2	0	3	1	4	2	6	3	8	6	10	8	13	13	19																						
	Fourth	50	200															0	3	1	4	2	5	3	7	5	10	8	13	12	17	19	25																						
	Fifth	50	250															1	3	2	4	3	6	5	8	7	11	11	15	17	20	25	29																						
	Sixth	50	300															1	3	3	5	4	6	7	9	10	12	14	17	21	23	31	33																						
	Seventh	50	350															2	3	4	5	6	7	9	10	13	14	18	19	25	26	37	38																						
M	First	80	80	↓		↓		↓		*		↑		↓		#	2	#	2	#	3	#	4	0	4	0	5	1	7	2	9	↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑	
	Second	80	160													#	2	0	3	0	3	1	5	1	6	3	8	4	10	7	14																								
	Third	80	240													0	2	0	3	1	4	2	6	3	8	6	10	8	13	13	19																								
	Fourth	80	320													0	3	1	4	2	5	3	7	5	10	8	13	12	17	19	25																								
	Fifth	80	400													1	3	2	4	3	6	5	8	7	11	11	15	17	20	25	29																								
	Sixth	80	480													1	3	3	5	4	6	7	9	10	12	14	17	21	23	31	33																								
	Seventh	80	560													2	3	4	5	6	7	9	10	13	14	18	19	25	26	37	38																								
N	First	125	125	↓		↓		*		↑		↓		#	2	#	2	#	3	#	4	0	4	0	5	1	7	2	9	↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑	
	Second	125	250											#	2	0	3	0	3	1	5	1	6	3	8	4	10	7	14																										
	Third	125	375											0	2	0	3	1	4	2	6	3	8	6	10	8	13	13	19																										
	Fourth	125	500											0	3	1	4	2	5	3	7	5	10	8	13	12	17	19	25																										
	Fifth	125	625											1	3	2	4	3	6	5	8	7	11	11	15	17	20	25	29																										
	Sixth	125	750											1	3	3	5	4	6	7	9	10	12	14	17	21	23	31	33																										
	Seventh	125	875											2	3	4	5	6	7	9	10	13	14	18	19	25	26	37	38																										
P	First	200	200	↓		*		↑		↓		#	2	#	2	#	3	#	4	0	4	0	5	1	7	2	9	↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑	
	Second	200	400									#	2	0	3	0	3	1	5	1	6	3	8	4	10	7	14																												
	Third	200	600									0	2	0	3	1	4	2	6	3	8	6	10	8	13	13	19																												
	Fourth	200	800									0	3	1	4	2	5	3	7	5	10	8	13	12	17	19	25																												
	Fifth	200	1000									1	3	2	4	3	6	5	8	7	11	11	15	17	20	25	29																												
	Sixth	200	1200									1	3	3	5	4	6	7	9	10	12	14	17	21	23	31	33																												
	Seventh	200	1400									2	3	4	5	6	7	9	10	13	14	18	19	25	26	37	38																												
Q	First	315	315	*		↑		↓		#	2	#	2	#	3	#	4	0	4	0	5	1	7	2	9	↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑	
	Second	315	630							#	2	0	3	0	3	1	5	1	6	3	8	4	10	7	14																														
	Third	315	945							0	2	0	3	1	4	2	6	3	8	6	10	8	13	13	19																														
	Fourth	315	1260							0	3	1	4	2	5	3	7	5	10	8	13	12	17	19	25																														
	Fifth	315	1575							1	3	2	4	3	6	5	8	7	11	11	15	17	20	25	29																														
	Sixth	315	1890							1	3	3	5	4	6	7	9	10	12	14	17	21	23	31	33																														
	Seventh	315	2205							2	3	4	5	6	7	9	10	13	14	18	19	25	26	37	38																														
R	First	500	500	↑		↑		#	2	#	2	#	3	#	4	0	4	0	5	1	7	2	9	↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑	
	Second	500	1000					#	2	0	3	0	3	1	5	1	6	3	8	4	10	7	14																																
	Third	500	1500					0	2	0	3	1	4	2	6	3	8	6	10	8	13	13	19																																
	Fourth	500	2000					0	3	1	4	2	5	3	7	5	10	8	13	12	17	19	25																																
	Fifth	500	2500					1	3	2	4	3	6	5	8	7	11	11	15	17	20	25	29																																
	Sixth	500	3000					1	3	3	5	4	6	7	9	10	12	14	17	21	23	31	33																																
	Seventh	500	3500					2	3	4	5	6	7	9	10	13	14	18	19	25	26	37	38																																

⇩ = Use first sampling plan below arrow. If sample size equals or exceeds lot or batch size, do 100 percent inspection.
⇧ = Use first sampling plan above arrow (refer to preceding page, when necessary).
Ac = Acceptance number.
Re = Rejection number.
* = Use corresponding single sampling plan (or alternatively, use multiple plan below, where available).
# = Acceptance not permitted at this sample size.

MULTIPLE
TIGHTENED

TABLE IV-B—Multiple sampling plans for tightened inspection (Master table)

Sample size code letter	Sample	Sample size	Cumulative sample size	Acceptable Quality Levels (tightened inspection)																																																			
				0.010		0.015		0.025		0.040		0.065		0.10		0.15		0.25		0.40		0.65		1.0		1.5		2.5		4.0		6.5		10		15		25		40		65		100		150		250		400		650		1000	
				Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re
A				⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		*		*		*		*		*		*		*		*	
B																																*						++		++		++		++		++		++		++		++		++	
C																														*		⇩				++		++		++		++		++		++		++		++		++		⇧	
D	First	2	2	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		*		⇩		⇩		#	2	#	2	#	3	#	4	0	4	0	6	1	8	3	10	6	15	⇧		⇧	
	Second	2	4																													#	2	0	3	0	3	1	5	2	7	3	9	6	12	10	17	16	25				
	Third	2	6																													0	2	0	3	1	4	2	6	4	9	7	12	11	17	17	24	26	36				
	Fourth	2	8																													0	3	1	4	2	5	3	7	6	11	10	15	16	22	24	31	37	46				
	Fifth	2	10																													1	3	2	4	3	6	5	8	9	12	14	17	22	25	32	37	49	55				
	Sixth	2	12																													1	3	3	5	4	6	7	9	12	14	18	20	27	29	40	43	61	64				
	Seventh	2	14																													2	3	4	5	6	7	9	10	14	15	21	22	32	33	48	49	72	73				
E	First	3	3	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		*		⇩		⇩		#	2	#	2	#	3	#	4	0	4	0	6	1	8	3	10	6	15	⇧		⇧		⇧	
	Second	3	6																													#	2	0	3	0	3	1	5	2	7	3	9	6	12	10	17	16	25						
	Third	3	9																													0	2	0	3	1	4	2	6	4	9	7	12	11	17	17	24	26	36						
	Fourth	3	12																													0	3	1	4	2	5	3	7	6	11	10	15	16	22	24	31	37	46						
	Fifth	3	15																													1	3	2	4	3	6	5	8	9	12	14	17	22	25	32	37	49	55						
	Sixth	3	18																													1	3	3	5	4	6	7	9	12	14	18	20	27	29	40	43	61	64						
	Seventh	3	21																													2	3	4	5	6	7	9	10	14	15	21	22	32	33	48	49	72	73						
F	First	5	5	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		*		⇩		⇩		#	2	#	2	#	3	#	4	0	4	0	6	1	8	⇧		⇧		⇧		⇧		⇧		⇧	
	Second	5	10																											#	2	0	3	0	3	1	5	2	7	3	9	6	12												
	Third	5	15																											0	2	0	3	1	4	2	6	4	9	7	12	11	17												
	Fourth	5	20																											0	3	1	4	2	5	3	7	6	11	10	15	16	22												
	Fifth	5	25																											1	3	2	4	3	6	5	8	9	12	14	17	22	25												
	Sixth	5	30																											1	3	3	5	4	6	7	9	12	14	18	20	27	29												
	Seventh	5	35																											2	3	4	5	6	7	9	10	14	15	21	22	32	33												
G	First	8	8	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		*		⇩		⇩		#	2	#	2	#	3	#	4	0	4	0	6	1	8	⇧		⇧		⇧		⇧		⇧		⇧		⇧	
	Second	8	16																									#	2	0	3	0	3	1	5	2	7	3	9	6	12														
	Third	8	24																									0	2	0	3	1	4	2	6	4	9	7	12	11	17														
	Fourth	8	32																									0	3	1	4	2	5	3	7	6	11	10	15	16	22														
	Fifth	8	40																									1	3	2	4	3	6	5	8	9	12	14	17	22	25														
	Sixth	8	48																									1	3	3	5	4	6	7	9	12	14	18	20	27	29														
	Seventh	8	56																									2	3	4	5	6	7	9	10	14	15	21	22	32	33														
H	First	13	13	⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		*		⇩		⇩		#	2	#	2	#	3	#	4	0	4	0	6	1	8	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
	Second	13	26																							#	2	0	3	0	3	1	5	2	7	3	9	6	12																
	Third	13	39																							0	2	0	3	1	4	2	6	4	9	7	12	11	17																
	Fourth	13	52																							0	3	1	4	2	5	3	7	6	11	10	15	16	22																
	Fifth	13	65																							1	3	2	4	3	6	5	8	9	12	14	17	22	25																
	Sixth	13	78																							1	3	3	5	4	6	7	9	12	14	18	20	27	29																
	Seventh	13	91																							2	3	4	5	6	7	9	10	14	15	21	22	32	33																
J	First	20	20	⇩		⇩		⇩		⇩		⇩		⇩		⇩		*		⇩		⇩		#	2	#	2	#	3	#	4	0	4	0	6	1	8	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
	Second	20	40																					#	2	0	3	0	3	1	5	2	7	3	9	6	12																		
	Third	20	60																					0	2	0	3	1	4	2	6	4	9	7	12	11	17																		
	Fourth	20	80																					0	3	1	4	2	5	3	7	6	11	10	15	16	22																		
	Fifth	20	100																					1	3	2	4	3	6	5	8	9	12	14	17	22	25																		
	Sixth	20	120																					1	3	3	5	4	6	7	9	12	14	18	20	27	29																		
	Seventh	20	140																					2	3	4	5	6	7	9	10	14	15	21	22	32	33																		

⇩ = Use first sampling plan below arrow (refer to continuation of table on following page, when necessary). If sample size equals or exceeds lot or batch size, do 100 percent inspection.
⇧ = Use first sampling plan above arrow.
Ac = Acceptance number
Re = Rejection number
* = Use corresponding single sampling plan (or alternatively, use multiple sampling plan below, where available).
++ = Use corresponding double sampling plan (or alternatively, use multiple sampling plan below, where available).
# = Acceptance not permitted at this sample size.

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TABLE IV-B — Multiple sampling plans for tightened inspection (Master table)
(Continued)

Sample size code letter	Sample	Sample size	Cumulative sample size	Acceptable Quality Levels (tightened inspection)																																																	
				0.010		0.015		0.025		0.040		0.065		0.10		0.15		0.25		0.40		0.65		1.0		1.5		2.5		4.0		6.5		10		15		25		40		65		100		150		250		400		650		1000	
				Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re
K	First	32	32	↓		↓		↓		↓		↓		↓		*		↓		↓		#	2	#	2	#	3	#	4	0	4	0	6	1	8	↑		↑		↑		↑		↑		↑		↑		↑		↑		↑	
	Second	32	64																			#	2	0	3	0	3	1	5	2	7	3	9	6	12																				
	Third	32	96																			0	2	0	3	1	4	2	6	4	9	7	12	11	17																				
	Fourth	32	128																			0	3	1	4	2	5	3	7	6	11	10	15	16	22																				
	Fifth	32	160																			1	3	2	4	3	6	5	8	9	12	14	17	22	25																				
	Sixth	32	192																			1	3	3	5	4	6	7	9	12	14	18	20	27	29																				
	Seventh	32	224																			2	3	4	5	6	7	9	10	14	15	21	22	32	33																				
L	First	50	50	↓		↓		↓		↓		↓		*		↓		↓		#	2	#	2	#	3	#	4	0	4	0	6	1	8	↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑	
	Second	50	100																	#	2	0	3	0	3	1	5	2	7	3	9	6	12																						
	Third	50	150																	0	2	0	3	1	4	2	6	4	9	7	12	11	17																						
	Fourth	50	200																	0	3	1	4	2	5	3	7	6	11	10	15	16	22																						
	Fifth	50	250																	1	3	2	4	3	6	5	8	9	12	14	17	22	25																						
	Sixth	50	300																	1	3	3	5	4	6	7	9	12	14	18	20	27	29																						
	Seventh	50	350																	2	3	4	5	6	7	9	10	14	15	21	22	32	33																						
M	First	80	80	↓		↓		↓		↓		*		↓		↓		#	2	#	2	#	3	#	4	0	4	0	6	1	8	↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑	
	Second	80	160															#	2	0	3	0	3	1	5	2	7	3	9	6	12																								
	Third	80	240															0	2	0	3	1	4	2	6	4	9	7	12	11	17																								
	Fourth	80	320															0	3	1	4	2	5	3	7	6	11	10	15	16	22																								
	Fifth	80	400															1	3	2	4	3	6	5	8	9	12	14	17	22	25																								
	Sixth	80	480															1	3	3	5	4	6	7	9	12	14	18	20	27	29																								
	Seventh	80	560															2	3	4	5	6	7	9	10	14	15	21	22	32	33																								
N	First	125	125	↓		↓		↓		*		↓		↓		#	2	#	2	#	3	#	4	0	4	0	6	1	8	↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑	
	Second	125	250													#	2	0	3	0	3	1	5	2	7	3	9	6	12																										
	Third	125	375													0	2	0	3	1	4	2	6	4	9	7	12	11	17																										
	Fourth	125	500													0	3	1	4	2	5	3	7	6	11	10	15	16	22																										
	Fifth	125	625													1	3	2	4	3	6	5	8	9	12	14	17	22	25																										
	Sixth	125	750													1	3	3	5	4	6	7	9	12	14	18	20	27	29																										
	Seventh	125	875													2	3	4	5	6	7	9	10	14	15	21	22	32	33																										
P	First	200	200	↓		↓		*		↓		↓		#	2	#	2	#	3	#	4	0	4	0	6	1	8	↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑	
	Second	200	400											#	2	0	3	0	3	1	5	2	7	3	9	6	12																												
	Third	200	600											0	2	0	3	1	4	2	6	4	9	7	12	11	17																												
	Fourth	200	800											0	3	1	4	2	5	3	7	6	11	10	15	16	22																												
	Fifth	200	1000											1	3	2	4	3	6	5	8	9	12	14	17	22	25																												
	Sixth	200	1200											1	3	3	5	4	6	7	9	12	14	18	20	27	29																												
	Seventh	200	1400											2	3	4	5	6	7	9	10	14	15	21	22	32	33																												
Q	First	315	315	↓		*		↓		↓		#	2	#	2	#	3	#	4	0	4	0	6	1	8	↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑	
	Second	315	630									#	2	0	3	0	3	1	5	2	7	3	9	6	12																														
	Third	315	945									0	2	0	3	1	4	2	6	4	9	7	12	11	17																														
	Fourth	315	1260									0	3	1	4	2	5	3	7	6	11	10	15	16	22																														
	Fifth	315	1575									1	3	2	4	3	6	5	8	9	12	14	17	22	25																														
	Sixth	315	1890									1	3	3	5	4	6	7	9	12	14	18	20	27	29																														
	Seventh	315	2205									2	3	4	5	6	7	9	10	14	15	21	22	32	33																														
R	First	500	500	*		↑		↓		#	2	#	2	#	3	#	4	0	4	0	6	1	8	↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑		↑	
	Second	500	1000							#	2	0	3	0	3	1	5	2	7	3	9	6	12																																
	Third	500	1500							0	2	0	3	1	4	2	6	4	9	7	12	11	17																																
	Fourth	500	2000							0	3	1	4	2	5	3	7	6	11	10	15	16	22																																
	Fifth	500	2500							1	3	2	4	3	6	5	8	9	12	14	17	22	25																																
	Sixth	500	3000							1	3	3	5	4	6	7	9	12	14	18	20	27	29																																
	Seventh	500	3500							2	3	4	5	6	7	9	10	14	15	21	22	32	33																																
S	First	800	800					#	2																																														
	Second	800	1600					#	2																																														
	Third	800	2400					0	2																																														
	Fourth	800	3200					0	3																																														
	Fifth	800	4000					1	3																																														
	Sixth	800	4800					1	3																																														
	Seventh	800	5600					2	3																																														

↓ = Use first sampling plan below arrow. If sample size equals or exceeds lot or batch size, do 100 percent inspection.
↑ = Use first sampling plan above arrow (refer to preceding page, when necessary).
Ac = Acceptance number
Re = Rejection number
* = Use corresponding single sampling plan (or alternatively, use multiple sampling plan below, where available).
# = Acceptance not permitted at this sample size.

TABLE IV-C — Multiple sampling plans for reduced inspection (Master table)

Sample size code letter	Sample	Sample size	Cumulative sample size	Acceptable Quality Levels (reduced inspection) †																																																			
				0.010		0.015		0.025		0.040		0.065		0.10		0.15		0.25		0.40		0.65		1.0		1.5		2.5		4.0		6.5		10		15		25		40		65		100		150		250		400		650		1000	
				Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re
A				⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		⇩		*		⇩		⇩		*		*		*		*		*		*		*		*		*	
B																														*		⇧				*		*		*		*		*		*		*		*		*		*	
C																												*		⇧		⇩		*		*		*		*		*		*		*		*		*		*		⇧	
D																										*		⇧		⇩		↔		↔		↔		↔		↔		↔		↔		↔		↔		↔		⇧			
E																								*		⇧		⇩		↔		↔		↔		↔		↔		↔		↔		↔		↔		↔		⇧					
F	First Second Third Fourth Fifth Sixth Seventh	2 2 2 2 2 2 2	2 4 6 8 10 12 14																			*		⇧		⇩		• • 0 0 0 0 1	2 2 2 3 3 3 3	• • 0 0 0 1 1	2 3 3 4 4 5 5	• • 0 0 1 1 2	3 3 4 5 6 6 7	• 0 0 1 2 3 4	3 4 5 6 7 7 8	• 0 1 2 3 4 6	4 5 6 7 8 9 10	• 1 2 3 5 7 9	4 6 8 10 11 12 14	0 1 3 5 7 10 13	5 7 9 12 13 15 17	0 3 6 8 11 14 18	6 9 12 15 17 20 22	⇧		⇧		⇧							
G	First Second Third Fourth Fifth Sixth Seventh	3 3 3 3 3 3 3	3 6 9 12 15 18 21																	*		⇧		⇩		• • 0 0 0 0 1	2 2 2 3 3 3 3	• • 0 0 0 1 1	2 3 3 4 4 5 5	• • 0 0 1 1 2	3 3 4 5 6 6 7	• 0 0 1 2 3 4	3 4 5 6 7 7 8	• 0 1 2 3 4 6	4 5 6 7 8 9 10	• 1 2 3 5 7 9	4 6 8 10 11 12 14	0 1 3 5 7 10 13	5 7 9 12 13 15 17	0 3 6 8 11 14 18	6 9 12 15 17 20 22	⇧													
H	First Second Third Fourth Fifth Sixth Seventh	5 5 5 5 5 5 5	5 10 15 20 25 30 35															*		⇧		⇩		• • 0 0 0 0 1	2 2 2 3 3 3 3	• • 0 0 0 1 1	2 3 3 4 4 5 5	• • 0 0 1 1 2	3 3 4 5 6 6 7	• 0 0 1 2 3 4	3 4 5 6 7 7 8	• 0 1 2 3 4 6	4 5 6 7 8 9 10	• 1 2 3 5 7 9	4 6 8 10 11 12 14	0 1 3 5 7 10 13	5 7 9 12 13 15 17	0 3 6 8 11 14 18	6 9 12 15 17 20 22	⇧															
J	First Second Third Fourth Fifth Sixth Seventh	8 8 8 8 8 8 8	8 16 24 32 40 48 56													*		⇧		⇩		• • 0 0 0 0 1	2 2 2 3 3 3 3	• • 0 0 0 1 1	2 3 3 4 4 5 5	• • 0 0 1 1 2	3 3 4 5 6 6 7	• 0 0 1 2 3 4	3 4 5 6 7 7 8	• 0 1 2 3 4 6	4 5 6 7 8 9 10	• 1 2 3 5 7 9	4 6 8 10 11 12 14	0 1 3 5 7 10 13	5 7 9 12 13 15 17	0 3 6 8 11 14 18	6 9 12 15 17 20 22	⇧																	
K	First Second Third Fourth Fifth Sixth Seventh	13 13 13 13 13 13 13	13 26 39 52 65 78 91											*		⇧		⇩		• • 0 0 0 0 1	2 2 2 3 3 3 3	• • 0 0 0 1 1	2 3 3 4 4 5 5	• • 0 0 1 1 2	3 3 4 5 6 6 7	• 0 0 1 2 3 4	3 4 5 6 7 7 8	• 0 1 2 3 4 6	4 5 6 7 8 9 10	• 1 2 3 5 7 9	4 6 8 10 11 12 14	0 1 3 5 7 10 13	5 7 9 12 13 15 17	0 3 6 8 11 14 18	6 9 12 15 17 20 22	⇧																			

⇩ = Use first sampling plan below arrow (refer to continuation of table on following page, when necessary). If sample size equals, or exceeds lot or batch size, do 100 percent inspection.
⇧ = Use first sampling plan above arrow
Ac = Acceptance number
Re = Rejection number
* = Use corresponding single sampling plan (or alternatively, use multiple sampling plan below, where available)
↔ = Use corresponding double sampling plan (or alternatively, use multiple sampling plan below, where available).
• = Acceptance not permitted at this sample size
† = If, after the final sample, the acceptance number has been exceeded, but the rejection number has not been reached, accept the lot but reinstate normal inspection (see 10.1.4).

TABLE IV-C—Multiple sampling plans for reduced inspection (Master table) (Continued)

Sample size code letter	Sample	Sample size	Cumulative sample size	Acceptable Quality Levels (reduced inspection)†																																																			
				0.010		0.015		0.025		0.040		0.065		0.10		0.15		0.25		0.40		0.65		1.0		1.5		2.5		4.0		6.5		10		15		25		40		65		100		150		250		400		650		1000	
				Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re	Ac	Re
L	First	20	20	⇩		⇩		⇩		⇩		•		⇧		⇩		•	2	•	2	•	3	•	3	•	4	•	4	0	5	0	6	⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧		⇧	
	Second	20	40															•	2	•	3	•	3	0	4	0	5	1	6	1	7	3	9																						
	Third	20	60															0	2	0	3	0	4	0	5	1	6	2	8	3	9	6	12																						
	Fourth	20	80															0	3	0	4	0	5	1	6	2	7	3	10	5	12	8	15																						
	Fifth	20	100															0	3	0	4	1	6	2	7	3	8	5	11	7	13	11	17																						
	Sixth	20	120															0	3	1	5	1	6	3	7	4	9	7	12	10	15	14	20																						
	Seventh	20	140															1	3	1	5	2	7	4	8	6	10	9	14	13	17	18	22																						
M	First	32	32							•		⇧		⇩		•	2	•	2	•	3	•	3	•	4	•	4	0	5	0	6	⇧																							
	Second	32	64													•	2	•	3	•	3	0	4	0	5	1	6	1	7	3	9																								
	Third	32	96													0	2	0	3	0	4	0	5	1	6	2	8	3	9	6	12																								
	Fourth	32	128													0	3	0	4	0	5	1	6	2	7	3	10	5	12	8	15																								
	Fifth	32	160													0	3	0	4	1	6	2	7	3	8	5	11	7	13	11	17																								
	Sixth	32	192													0	3	1	5	1	6	3	7	4	9	7	12	10	15	14	20																								
	Seventh	32	224													1	3	1	5	2	7	4	8	6	10	9	14	13	17	18	22																								
N	First	50	50					•		⇧		⇩		•	2	•	2	•	3	•	3	•	4	•	4	0	5	0	6	⇧																									
	Second	50	100											•	2	•	3	•	3	0	4	0	5	1	6	1	7	3	9																										
	Third	50	150											0	2	0	3	0	4	0	5	1	6	2	8	3	9	6	12																										
	Fourth	50	200											0	3	0	4	0	5	1	6	2	7	3	10	5	12	8	15																										
	Fifth	50	250											0	3	0	4	1	6	2	7	3	8	5	11	7	13	11	17																										
	Sixth	50	300											0	3	1	5	1	6	3	7	4	9	7	12	10	15	14	20																										
	Seventh	50	350											1	3	1	5	2	7	4	8	6	10	9	14	13	17	18	22																										
P	First	80	80			•		⇧		⇩		•	2	•	2	•	3	•	3	•	4	•	4	0	5	0	6	⇧																											
	Second	80	160									•	2	•	3	•	3	0	4	0	5	1	6	1	7	3	9																												
	Third	80	240									0	2	0	3	0	4	0	5	1	6	2	8	3	9	6	12																												
	Fourth	80	320									0	3	0	4	0	5	1	6	2	7	3	10	5	12	8	15																												
	Fifth	80	400									0	3	0	4	1	6	2	7	3	8	5	11	7	13	11	17																												
	Sixth	80	480									0	3	1	5	1	6	3	7	4	9	7	12	10	15	14	20																												
	Seventh	80	560									1	3	1	5	2	7	4	8	6	10	9	14	13	17	18	22																												
Q	First	125	125	•		⇧		⇩		•	2	•	2	•	3	•	3	•	4	•	4	0	5	0	6	⇧																													
	Second	125	250							•	2	•	3	•	3	0	4	0	5	1	6	1	7	3	9																														
	Third	125	375							0	2	0	3	0	4	0	5	1	6	2	8	3	9	6	12																														
	Fourth	125	500							0	3	0	4	0	5	1	6	2	7	3	10	5	12	8	15																														
	Fifth	125	625							0	3	0	4	1	6	2	7	3	8	5	11	7	13	11	17																														
	Sixth	125	750							0	3	1	5	1	6	3	7	4	9	7	12	10	15	14	20																														
	Seventh	125	875							1	3	1	5	2	7	4	8	6	10	9	14	13	17	18	22																														
R	First	200	200	⇧				•	2	•	2	•	3	•	3	•	4	•	4	0	5	0	6	⇧																															
	Second	200	400					•	2	•	3	•	3	0	4	0	5	1	6	1	7	3	9																																
	Third	200	600					0	2	0	3	0	4	0	5	1	6	2	8	3	9	6	12																																
	Fourth	200	800					0	3	0	4	0	5	1	6	2	7	3	10	5	12	8	15																																
	Fifth	200	1000					0	3	0	4	1	6	2	7	3	8	5	11	7	13	11	17																																
	Sixth	200	1200					0	3	1	5	1	6	3	7	4	9	7	12	10	15	14	20																																
	Seventh	200	1400					1	3	1	5	2	7	4	8	6	10	9	14	13	17	18	22																																

⇩ = Use first sampling plan below arrow. If sample size equals, or exceeds, lot or batch size, do 100 percent inspection.
⇧ = Use first sampling plan above arrow (refer to preceding page when necessary).
Ac = Acceptance number
Re = Rejection number
• = Acceptance not permitted at this sample size
† = If, after the final sample, the acceptance number has been exceeded, but the rejection number has not been reached, accept the lot, but reinstate normal inspection (see 10.1.4).

TABLE VIII — Limit Numbers for Reduced Inspection

Number of sample units from last 10 lots or batches	Acceptable Quality Level																									
	0.010	0.015	0.025	0.040	0.065	0.10	0.15	0.25	0.40	0.65	1.0	1.5	2.5	4.0	6.5	10	15	25	40	65	100	150	250	400	650	1000
20 - 29	•	•	•	•	•	•	•	•	•	•	•	•	•	•	•	0	0	2	4	8	14	22	40	68	115	181
30 - 49	•	•	•	•	•	•	•	•	•	•	•	•	•	•	0	0	1	3	7	13	22	36	63	105	178	277
50 - 79	•	•	•	•	•	•	•	•	•	•	•	•	•	0	0	2	3	7	14	25	40	63	110	181	301	
80 - 129	•	•	•	•	•	•	•	•	•	•	•	•	0	0	2	4	7	14	24	42	68	105	181	297		
130 - 199	•	•	•	•	•	•	•	•	•	•	•	0	0	2	4	7	13	25	42	72	115	177	301	490		
200 - 319	•	•	•	•	•	•	•	•	•	•	0	0	2	4	8	14	22	40	68	115	181	277	471			
320 - 499	•	•	•	•	•	•	•	•	•	0	0	1	4	8	14	24	39	68	113	189						
500 - 799	•	•	•	•	•	•	•	•	0	0	2	3	7	14	25	40	63	110	181							
800 - 1249	•	•	•	•	•	•	•	0	0	2	4	7	14	24	42	68	105	181								
1250 - 1999	•	•	•	•	•	•	0	0	2	4	7	13	24	40	69	110	169									
2000 - 3149	•	•	•	•	•	0	0	2	4	8	14	22	40	68	115	181										
3150 - 4999	•	•	•	•	0	0	1	4	8	14	24	38	67	111	186											
5000 - 7999	•	•	•	0	0	2	3	7	14	25	40	63	110	181												
8000 - 12499	•	•	0	0	2	4	7	14	24	42	68	105	181													
12500 - 19999	•	0	0	2	4	7	13	24	40	69	110	169														
20000 - 31499	0	0	2	4	8	14	22	40	68	115	181															
31500 - 49999	0	1	4	8	14	24	38	67	111	186																
50000 & Over	2	3	7	14	25	40	63	110	181	301																

* Denotes that the number of sample units from the last ten lots or batches is not sufficient for reduced inspection for this AQL. In this instance more than ten lots or batches may be used for the calculation, provided that the lots or batches used are the most recent ones in sequence, that they have all been on normal inspection, and that none has been rejected while on original inspection.

TABLE A, ALLOWANCES FOR PROCESS AVERAGE COMPARISON LIMITS

Number of Sample Units Included in Estimated Process Average	QUALITY ASSURANCE REPRESENTATIVE'S PROCESS AVERAGE (QARPA) RANGES													
	0.0 to 0.055	0.056 to 0.108	0.109 to 0.164	0.165 to 0.220	0.221 to 0.279	0.280 to 0.360	0.361 to 0.439	0.440 to 0.600	0.601 to 0.699	0.700 to 0.900	0.91 to 1.09	1.10 to 1.35	1.36 to 1.64	1.65 to 2.20
6-12	*													
13-18	*													
19-24	*													
25-34	*													5.81
35-49	*												6.94	6.38
50-74	*										4.911	4.66	4.37	5.81
75-99	1.334									2.901	2.911	2.66	3.70	4.47
100-124	1.000								2.301	2.101	2.911	2.66	3.37	3.81
125-149	0.800							1.801	1.701	1.501	2.111	2.66	2.87	3.41
150-199	0.750						1.562	1.401	1.500	1.767	2.244	2.66	3.03	2.60
200-249	0.500					1.141	1.062	1.401	1.301	1.601	1.911	2.16	2.37	2.81
250-299	0.400					0.841	0.762	1.001	1.301	1.401	1.511	1.86	1.97	2.21
300-349	0.334				0.722	0.641	0.895	1.067	0.969	1.101	1.244	1.66	1.70	2.14
350-399	0.287				0.579	0.783	0.704	0.829	0.960	1.101	1.196	1.41	1.51	1.81
400-449	0.250			0.531	0.581	0.641	0.812	0.901	0.801	1.101	1.161	1.16	1.37	1.56
450-549	0.223		0.503	0.447	0.610	0.752	0.673	0.956	0.857	1.101	1.133	1.32	1.48	1.81
550-649	0.183		0.382	0.508	0.449	0.550	0.652	0.673	0.756	0.919	1.092	1.20	1.27	1.62
650-749	0.309		0.299	0.550	0.491	0.564	0.638	0.631	0.686	0.793	0.911	1.12	1.13	1.16
750-899	0.267		0.370	0.447	0.388	0.441	0.628	0.601	0.769	0.834	0.911	1.06	0.93	1.08
900-1099	0.223	0.225	0.281	0.336	0.388	0.529	0.561	0.623	0.746	0.767	0.911	0.77	0.87	0.98
1100-1299	0.183	0.256	0.291	0.417	0.358	0.459	0.471	0.582	0.574	0.737	0.627	0.70	0.77	0.89
1300-1499	0.232	0.200	0.221	0.319	0.337	0.333	0.408	0.477	0.532	0.524	0.576	0.64	0.71	0.82
1500-1699	0.200	0.190	0.236	0.313	0.322	0.374	0.361	0.401	0.431	0.488	0.536	0.60	0.66	0.76
1700-1899	0.176	0.186	0.189	0.507	0.251	0.278	0.364	0.401	0.405	0.458	0.504	0.56	0.62	0.72
1900-2249	0.158	0.155	0.205	0.254	0.300	0.325	0.351	0.453	0.383	0.433	0.477	0.53	0.59	0.67

* Comparability is established only if contractor's process average is zero.

TABLE A, ALLOWANCES FOR PROCESS AVERAGE COMPARISON LIMITS (continued)

Number of Sample Units Included in Estimated Process Average	QUALITY ASSURANCE REPRESENTATIVE'S PROCESS AVERAGE (QARPA) RANGES												
	2.21 to 2.79	2.80 to 3.60	3.61 to 4.39	4.40 to 6.00	6.01 to 6.99	7.0 to 9.0	9.1 to 10.9	11.0 to 13.5	13.6 to 16.4	16.5 to 22.0	22.1 to 27.9	28.0 to 36.0	36.1 to 43.9
6-12				25.34	26.35	25.35	35.10	36.51	33.61	36.34	47.11	47.34	39.44
13-18			15.84	16.03	26.35	25.35	22.43	25.39	22.49	28.01	27.66	36.23	33.88
19-24		13.07	12.28	19.01	18.01	17.01	18.26	24.01	21.11	23.84	26.27	26.51	31.11
25-34	9.22	14.05	13.26	11.65	13.60	12.59	15.57	20.51	15.96	19.18	22.11	22.83	23.75
35-49	8.64	8.65	7.86	8.29	11.38	11.41	9.50	13.04	12.18	14.74	17.01	19.11	19.37
50-74	6.22	5.86	5.67	7.52	6.53	8.57	8.01	9.48	9.28	11.89	12.65	13.58	14.04
75-99	5.22	5.50	5.72	5.12	6.14	6.17	8.29	8.73	7.85	9.57	10.36	11.09	11.46
100-124	4.43	4.47	4.49	5.30	5.11	6.34	6.84	6.83	7.41	8.29	8.97	9.61	9.93
125-149	3.62	3.61	4.42	5.21	5.82	6.44	5.58	6.12	6.63	7.41	8.03	8.59	8.88
150-199	3.88	4.41	4.95	6.01	6.35	4.43	5.09	5.59	6.05	6.77	7.33	7.84	8.11
200-249	3.22	3.41	4.12	5.01	3.61	3.84	4.41	4.84	5.24	5.83	6.35	6.79	7.02
250-299	2.42	3.21	3.22	3.01	2.23	3.44	3.95	4.32	4.69	5.24	5.68	6.08	6.28
300-349	2.22	2.74	2.37	2.75	2.95	3.14	3.60	3.95	4.27	4.79	5.18	5.55	5.74
350-399	2.07	2.00	2.19	2.54	2.73	2.90	3.34	3.66	3.95	4.43	4.80	5.14	5.31
400-449	1.97	1.87	2.05	2.39	2.46	2.72	3.12	3.42	3.71	4.15	4.49	4.81	4.97
450-549	1.56	1.76	1.94	2.24	2.41	2.56	2.94	3.23	3.49	3.91	4.23	4.53	4.68
550-649	1.41	1.59	1.75	2.03	2.18	2.32	2.66	2.92	3.16	3.54	3.83	4.10	4.24
650-749	1.30	1.47	1.61	1.87	2.01	2.13	2.45	2.69	2.91	3.25	3.52	3.77	3.90
750-899	1.21	1.36	1.50	1.74	1.87	1.99	2.28	2.60	2.71	3.03	3.28	3.51	3.63
900-1099	1.10	1.25	1.37	1.59	1.70	1.81	2.08	2.28	2.47	2.77	2.99	3.21	3.31
1100-1299	1.00	1.13	1.24	1.47	1.54	1.64	1.88	2.06	2.24	2.50	2.71	2.90	3.00
1300-1499	0.92	1.04	1.14	1.32	1.42	1.51	1.73	1.90	2.06	2.30	2.49	2.67	2.76
1500-1699	0.86	0.97	1.06	1.23	1.32	1.41	1.61	1.77	1.92	2.14	2.32	2.47	2.57
1700-1899	0.80	0.91	1.00	1.16	1.24	1.32	1.52	1.66	1.80	2.01	2.18	2.33	2.41
1900-2249	0.76	0.86	0.95	1.09	1.17	1.25	1.44	1.57	1.70	1.91	2.06	2.21	2.28

TABLE B

SKIP-LOT VERIFICATION EXAMINATION LIMITS

(Used when verifications are performed at other than Level A)

END RANGE		LWL	UWL	UCL	END RANGE		LWL	UWL	UCL	END RANGE		LWL	UWL	UCL	END RANGE		LWL	LWL	UCL
0	0.02	-	2	2	13.5	14.1	7	21	26	36.1	37.0	26	49	56	72.1	74.0	58	91	101
0.03	0.19	-	2	2	14.2	14.9	8	22	27	37.1	38.0	27	50	57	74.1	76.0	60	93	103
0.20	0.46	-	2	3	15.0	15.6	8	23	28	38.1	39.0	28	51	59	76.1	78.0	62	95	105
0.47	0.80	-	3	4	15.7	16.3	9	24	29	39.1	40.0	29	52	60	78.1	80.0	64	97	108
0.81	1.20	-	3	5	16.4	17.0	10	25	30	40.1	41.0	30	53	61	80.1	82.0	65	100	110
1.21	1.64	-	4	6	17.1	17.8	10	26	31	41.1	42.0	31	55	62	82.1	84.0	67	102	113
1.65	2.12	-	5	7	17.9	18.5	11	27	32	42.1	43.0	32	56	64	84.1	86.0	69	104	115
2.13	2.63	-	6	8	18.6	19.3	11	28	33	43.1	44.0	32	57	65	86.1	88.0	71	106	117
2.64	3.16	0	6	9	19.4	20.0	12	29	34	44.1	45.0	33	58	66	88.1	90.0	73	109	119
3.17	3.73	0	7	10	20.1	21.0	13	30	36	45.1	46.0	34	59	67	90.1	92.0	75	111	122
3.74	4.30	0	8	11	21.1	22.0	14	31	37	46.1	47.0	35	60	69	92.1	94.0	77	113	124
4.31	4.89	0	9	12	22.1	23.0	14	32	38	47.1	48.0	36	62	70	94.1	96.0	78	115	126
4.90	5.48	1	10	13	23.1	24.0	15	33	40	48.1	49.0	37	63	71	96.1	98.0	80	117	129
5.49	6.09	1	11	14	24.1	25.0	16	34	41	49.1	50.0	38	64	72	98.1	100.0	82	119	131
6.10	6.74	2	12	15	25.1	26.0	17	36	42	50.1	52.0	39	66	75	100.1	105.0	85	125	137
6.75	7.35	2	13	16	26.1	27.0	18	37	44	52.1	54.0	40	68	77	105.1	110.0	90	131	142
7.36	8.00	3	14	17	27.1	28.0	19	38	45	54.1	56.0	42	71	79	110.1	115.0	95	136	148
8.01	8.68	3	15	18	28.1	29.0	19	39	46	56.1	58.0	44	73	81	115.1	120.0	99	141	154
8.69	9.34	3	16	19	29.1	30.0	20	40	47	58.1	60.0	46	75	84	120.1	125.0	104	147	160
9.35	10.0	4	17	20	30.1	31.0	21	42	49	60.1	62.0	47	78	87	125.1	130.0	108	152	165
10.1	10.6	4	18	21	31.1	32.0	22	43	50	62.1	64.0	49	80	89	130.1	135.0	112	158	171
10.7	11.3	5	18	22	32.1	33.0	23	44	51	64.1	66.0	51	82	91	135.1	140.0	118	163	176
11.4	12.0	5	19	23	33.1	34.0	24	45	52	66.1	68.0	53	84	94	140.1	145.0	122	168	182
12.1	12.7	6	20	24	34.1	35.0	25	46	54	68.1	70.0	55	86	96	145.1	150.0	127	174	188
12.8	13.4	6	20	25	35.1	36.0	25	48	55	70.1	72.0	57	89	98					

LWL - Lower Warning Limit

UWL - Upper Warning Limit

UCL - Upper Control Limit

END - Expected Number of Defects

$$\text{END} = \frac{\text{Contractor's Process Average} \times \text{Number of Sample Units in Verification Examination}}{100}$$

AU GAFS,ALA.(752343)700

1-2

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WORKBOOK

The Veterinary Airman, Administration, and Principles of
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Answers For Chapter Review Exercises

Volume Review Exercise

ECI Form No. 17

STUDY REFERENCE GUIDE

1. *Use this Guide as a Study Aid.* It emphasizes all important study areas of this volume.

2. *Use the Guide as you complete the Volume Review Exercise and for Review after Feedback on the Results.* After each item number on your VRE is a three digit number in parenthesis. That number corresponds to the Guide Number in this Study Reference Guide which shows you where the answer to that VRE item can be found in the text. When answering the items in your VRE, refer to the areas in the test indicated by these Guide Numbers. The VRE results will be sent to you on a postcard which will list the *actual VRE items you missed.* Go to your VRE booklet and locate the Guide Number for each item missed. List these Guide Numbers. Then go back to your textbook and carefully review the areas covered by these Guide Numbers. Review the entire VRE again before you take the closed-book Course Examination.

3. *Use the Guide for Follow-up after you complete the Course Examination.* The CE results will be sent to you on a postcard, which will indicate "Satisfactory" or "Unsatisfactory" completion. The card will list *Guide Numbers* relating to the questions missed. Locate the numbers in the Guide and draw a line under the Guide Number, topic, and reference. Review these areas to insure your mastery of the course.

Guide Numbers 100 through 110

Guide Number	
100	Introduction to The Veterinary Airman Career Field; Veterinary Service; pages 1–2
101	Career Advancement; pages 2–7
102	Standards of Conduct; pages 7–8
103	Introduction to Administration of the Base Veterinary Service; Training–Dual Channel OJT; Orienting Newly Assigned Personnel; Evaluating; pages 9–13
104	The Role of a Noncommissioned Officer; Budget; Supply Requirements; pages 13–18
105	Publications; pages 18–21
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108	Records and Reports; pages 37–40
109	Introduction to Government Verification of Contractor Inspection; Types of Verification Inspections; Determining Comparability; pages 41–46
110	Evaluating the Contractor's Examination System; Destination Inspection of Subsistence Under Origin Contractor Inspection with Government Verification; Government Verification of Contractor-Inspected Products not on Attribute Inspection; Major Subsistence Item Verification Inspection; pages 47–48

MODIFICATIONS

Pages 2- 8 of this publication has (have) been deleted in adapting this material for inclusion in the "Trial Implementation of a Model System to Provide Military Curriculum Materials for Use in Vocational and Technical Education." Deleted material involves extensive use of military forms, procedures, systems, etc. and was not considered appropriate for use in vocational and technical education.

CHAPTER 3

Objective: To be able to define certain terms and properly apply inspection by attributes. To compile sample plans with the aid of certain data and tables and to use the proper procedure in selecting samples to be examined.

1. List the four special inspection levels. (13-1)

2. Define the following: (a) Sample, (b) Sample plan, and (c) Sample size. (13-1)

3. List the steps you must accomplish to extract a sample plan. (14-2)

4. How is the lot size determined? (14-3)

5. If inspection levels are not indicated, what level is normally used? (14-4)

6. When you are doing destination inspection, what type inspection level should you use? (14-4)

Note to student: To answer exercises 7, 8, 9, and 10, use the tables in the Pamphlet of Sampling Plan Tables to determine the sample size code letters.

7.

Lot Size	Inspection Level	Code Letter
10 (14-5)	S-2	

8.

Lot Size	Inspection Level	Code Letter
150,002 (14-5)	S-4	

9.

Lot Size	Inspection Level	Code Letter
75 (14-5)	I	

10.

Lot Size	Inspection Level	Code Letter
3,202 (14-5)	III	

11. What type sampling plan is normally used for new contractors? (14-7)

12. Although double and multiple sampling plans have certain advantages, why are they rarely used? (14-7)

13. What are the three levels of severity inspection used with sampling plans? (14-8)

14. What is the difference between tightened and normal inspection? (14-9)

15. Which plan makes it easier to reject poor quality products? (14-9)

16. What type inspection allows the contractor more defects? (14-10)

17. If more than one test or examination must be performed, how many sample plans must you extract if you have three AQLs? (14-12)

Note to student: To answer exercises 18, 19, and 20, use the tables located in the Pamphlet of Sampling Plan Tables to extract the sample plans.

18. Given: Lot size–1150; Inspection level–S-4; AQL–4.0; and Severity of inspection–normal.
Find: Sample size code letter ___________, Sample size _________; Ac _________; and Re ________. (14-13–23)

19. Given: Lot size–450; Inspection level–II; AQL–6.5; and Severity of inspection–tightened.
Find: Sample size code letter __________; Sample size __________; Ac __________; and Re _________. (14-13–23)

20. Given: Lot size–275; Inspection level–II; AQL–6.5; and Severity of inspection–reduced.
Find: Sample size code letter __________ ; Sample size ___________; Ac ___________; and Re _________. (14-13–23)

21. You are ready to select five samples from a lot of 100 cases which have been prenumbered 001 to 100. You have let a pencil drop blindly on column 5, line 10 (53060) of the table of random numbers and have decided to read down using the first two digits of each line. What would your sample numbers be? (14-25–27)

22. You are doing origin inspection on beef steaks and are about to draw your samples. Who should be present at this time? (14-29)

23. The samples you want to draw are warehoused in such a manner that you cannot physically reach them. What should you do? (14-29)

24. When you change the severity of inspection, what is this action called? (14-36)

25. Before changing the severity of inspection from tightened to reduced, or from reduced to tightened, what must you do? (14-36)

26. The contractor is operating on *normal* severity of inspection and you have changed the severity to tightened inspection because of the rejection of two out of five consecutive lots. Did you take the proper action and why? (14-37)

27. When a contractor is on tightened inspection, how many lots must pass before he is returned to normal inspection? (14-38)

28. When normal inspection is in effect, can reduced inspection be instituted if ten lots have passed production at an unsteady rate? Why? (14-40)

29. Reduced inspection of a contractor has been instituted when a lot is rejected. What must be done? (14-41)

30. What form would you use to record the results of an inspection of a product? (15-1)

31. What manual would you use as a reference for detail procedures on preparation of DD Form 1714? (15-2)

32. You have just finished an inspection during which your work copy of DD Form 1714 became very blood-smeared. What would you do? (15-3)

33. During an inspection you find a defect which is a health hazard. Where should your report of this inspection be made? (15-4)

34. List two serious defects which are health hazards. (15-4)

35. If a B-unit contains two broken crackers which were placed in the unit by the same operator, how many defects would you record? (15-5)

36. When your examination is based on the number of defective units involving AQLs expressed as percent defective, is the acceptability based on the number of defective units or the number of defects? (15-6)

65

37. If you are assigned as an inspector at Grandy and Company of Omaha, Nebraska, who produces bacon, canned hams, and sausage for the Government, how many quality history records will you have to prepare? (15-8)

38. On what basis are quality history records maintained? (15-10)

39. Define process average. (15-12)

40. When five AQLs are involved, how many process averages will you compute? (15-12)

Complete exercises 41 and 42 by computing the process averages (PAs).

41. (15-12–19)

Lot Number	Sample Size	Major A Def AQL 4.0	Minor Def AQL 2.5
1	170	6	2
2	170	3	5
3	170	2	2
4	170	1	1

42. (15-12–19)

Lot Number	Sample Size	Major A Def AQL 4.0	Minor Def AQL 2.5
1	215	6	2
2	215	4	6
3	215	1	0
4	215	3	0
5	215	2	5

MODIFICATIONS

Pages 14- 20 of this publication has (have) been deleted in adapting this material for inclusion in the "Trial Implementation of a Model System to Provide Military Curriculum Materials for Use in Vocational and Technical Education." Deleted material involves extensive use of military forms, procedures, systems, etc. and was not considered appropriate for use in vocational and technical education.

CHAPTER 3

1. S–1, S–2, S–3, and S–4.

2. (a) Sample: One or more units of product selected at random to be inspected. (b) Sample plan: A designated sample size and its accompanying criteria or requirements for acceptance or rejection. (3) Sample size: The total number of units of product in the sample.

3. (1) Determine the lot size.
   (2) Obtain the inspection level.
   (3) Determine the sample size code letter.
   (4) Select the type of sampling plan.
   (5) Establish the severity of inspection.
   (6) Obtain the AQL.
   (7) Determine the sample size and the acceptance and rejection number.

4. By an agreement between the Government inspector and the vendor.

5. Inspection level II is used.

6. Level S–3.

7. A.

8. J.

9. C.

10. M.

11. Single sampling plan.

12. Administrative difficulties occur when they are employed in most subsistence contracts.

13. Normal, tightened, and reduced.

14. The number of defects allowed for tightened inspection are fewer than those for normal inspection.

15. Tightened.

16. Reduced.

17. Three.

18.

Code Letter	Sample Size	Ac	Re
F	20	2	3

19.

Code Letter	Sample Size	Ac	Re
H	50	5	6

20.

Code Letter	Sample Size	Ac	Re
G	13	2	5

21. 1. 53
    2. 70
    3. 49
    4. 88
    5. 48

22. The contractor or his authorized representative.

23. Arrange for withdrawal by an employee of the establishment under your supervision.

24. Switching or switching procedures.

25. Return to normal inspection.

26. Yes. When normal inspection is in effect, tightened inspection shall be instituted when two out of five consecutive lots have been rejected.

27. Five consecutive lots.

28. No, production has to be at a steady rate.

29. Return to normal inspection.

30. DD Form 1714, Product Verification Record.

31. *Defense Personnel Support Center Subsistence Inspection Manual*, subsection 208.1.

32. Redo the official copy later, but retain and file the original work copy.

33. Report it to your supervisor and then to the vendor and the Quality Assurance Element of the Procuring DPSC Headquarters.

34. Presence of foreign material and vacuum less than 22 inches.

35. One.

36. Based on the number of defective units.

37. Three, one for each item.

38. Lot-by-lot basis.

39. The average number of defects per hundred units or defectives of a product found at the time of the original inspection.

40. Five.

41. Major A = 1.76 PA; Minor = 1.47 PA.

42. Major A = 1.49; Minor = 1.21 PA.

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STOP–

1. MATCH ANSWER SHEET TO THIS EXERCISE NUMBER.

2. USE NUMBER 1 PENCIL.

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VOLUME REVIEW EXERCISE

Chapter 3

41. (107) One hundred times the number of defects contained in any given quantity of a product divided by the total number of units of a product inspected is the definition of

a. attribute inspection.
b. defects per hundred units.
c. computing comparability.
d. contractor's process average.

42. (107) How many special inspection levels are involved in attribute inspection?

a. Four.
b. Five.
c. Six.
d. Seven.

43. (107) In extracting a sample plan, you find that there is no inspection level listed inthe specification. You should use

a. Inspection level S–2.
b. Inspection level II.
c. Inspection level S–3.
d. Inspection level III.

44. (107) What level of inspection should you use at destination when inspecting for condition and identity?

a. Inspection level II.
b. Inspection level III.
c. Inspection level S–2.
d. Inspection level S–3.

45. (107) What type sampling plan would you use for a new contractor?

a. Single sampling plan.
b. Double sampling plan.
c. Multiple sampling plan.
d. Double and multiple sampling plan.

46. (107) In inspection by attributes, how many levels of severity of inspection are there?

a. One.
b. Two.
c. Three.
d. Four.

47. (107) During attribute inspection, you receive a contract containing four AQLs. How many sampling plans should you extract?

a. One.
b. Two.
c. Three.
d. Four.

48. (107) In inspection by attributes, a sample selection procedire is known as

a. selective sampling.
b. random sampling.
c. sampling by numbers.
d. representative sampling.

49. (107) Let us assume that you have selected a sample plan on a given lot of a product and you now are ready to identify your samples. You also know how many units are in the lot. Your next step is to

a. pull the samples.
b. number every other unit.
c. number each unit.
d. number up to 100 units only.

50. (107) You are about to draw your samples at origin inspection. Who should be present?

a. Contractor.
b. NCOIC, Veterinary Office.
c. QAL officer.
d. Contracting officer.

51. (107) Inspection by attributes provides us with a method whereby we may change from one severity of inspection to another. This changing of severity is called

a. reaccomplishing procedures.
b. exchanging procedures.
c. changing procedures.
d. switching procedures.

52. (107) On original inspection, when normal inspection by attributes is in effect, tightened inspection is instituted if out of consecutive lots

a. one of four is rejected.
b. two of four is rejected.
c. one of five is rejected.
d. two of five is rejected.

53. (107) If a contractor is operating on tightened inspection, how many lots must be considered acceptable before returning to normal inspection?

a. Three.
b. Four.
c. Five.
d. Six.

54. (107) Before switching from tightened to reduced inspection or from reduced to tightened, what action must be taken first?

a. Return to regular severity.
b. Return to normal severity.
c. Return to reduced severity.
d. Return to tightened severity.

55. (108) If your DD Form 1714 becomes extremely messy during an inspection, you should

a. reaccomplish the official copy and file your work copy.
b. reaccomplish the official copy and destroy your work copy.
c. not reaccomplish the official copy because your work copy is the official copy.
d. reaccomplish your work copy after notifying your supervisor and the contractor that you are going to do so.

56. (108) You have found a serious defect resulting in a health hazard and you have reported the incident to your supervisor and the vendor. Who else should be informed?

a. The local health officer.
b. The local USDA officer.
c. The contracting officer DPSC.
d. The Quality Assurance Element of DPSC.

57. (108) If a B–Unit contains two broken crackers which were placed in the unit by the same operator, how many defects will you record?

a. One.
b. Two.
c. Three.
d. Four.

58. (108) A separate process average is computed for each

a. lot.
b. AQL.
c. sample.
d. sample unit.

59. (108) In attribute inspection, how many places beyond the decimal point are we required to compute process averages if the third place is not a five?

a. Four.
b. Three.
c. Two.
d. One.

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CDC 90850

VETERINARY SERVICES SPECIALIST

(AFSC 90850)

Volume 2

Veterinary Microbiology; Consumer Level Quality
Audit Program; Food Technology;
Operational Ration and Egg Inspection

Extension Course Institute

Air University

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Preface

THIS CDC IS DESIGNED to expand your knowledge in all the duties that are performed by veterinary specialists throughout the Air Force. You are not performing all the functions discussed in this CDC. Your next assignment may be with a class 3 operation, with a base veterinary service, or may be restricted to military working dogs. Regardless of future assignments, discussions in this CDC will prepare you for the job to which you are now assigned, and for those that you will accomplish during your Air Force Veterinary career.

This volume is divided into five chapters. The first, Veterinary Microbiology, discusses cells, microorganisms, sterilization, the microscope, collecting and submitting specimens for laboratory analyses, as well as some common laboratory procedures. The last chapter deals with egg inspections. The preservation, storage, and processing of eggs will also be discussed. Located at the end of chapter 5 is a glossary.

Printed and bound in the back of this volume are foldouts 1 through 3. Whenever you are referred to one of these foldouts in the text, please turn to the back of the volume and locate the foldout.

If you have questions on the accuracy or currency of the subject matter of this text, or recommendations for its improvement, send them to School of Health Care Sciences/MSTW/114, Sheppard AFB TX 76311.

If you have questions on course enrollment or administration, or on any of ECI's instructional aids (Your Key to Career Development, Study Reference Guides, Chapter Review Exercises, Volume Review Exercise, and Course Examination), consult your education officer, training officer, or NCO, as appropriate. If he can't answer your questions, send them to ECI, Gunter AFS AL 36118, preferably on ECI Form 17, Student Request for Assistance.

This volume is valued at 24 hours (8 points).

Material in this volume is technically accurate, adequate, and current as of August 1974.

CHAPTER 1

Veterinary Microbiology

MICROBIOLOGY may be defined by analyzing the root words from which it is formed—micro means "too small to be seen by the naked eye"; biology is "the study of living things." Thus the definition of microbiology is "the study of living things too small to be seen with the naked eye."

2. There is no need for this text to try to teach you all that is known about microbiology because there are hundreds of thousands of microorganisms that will be of no concern to you as a veterinary specialist. There are, however, certain "microbes" that you will be directly associated with and it is these microorganisms with which we will concern ourselves.

3. When you have completed this chapter, you should have a basic understanding of microbiology and its relationship to food spoilage, sanitation, and the importance of proper sterilization and sterile techniques as far as the veterinary service is concerned. In addition, you should know the proper procedures for preparing and submitting specimens to the laboratory, and for performing some of the basic laboratory procedures used in food analysis.

1. Structure of Cells

1-1. Before you can understand microorganisms, you must understand the living cell, the basic unit of all living things. Whether an organism be microscopic or macroscopic, the smallest living unit of the organism is the cell. The smallest microorganisms are composed of only one cell, and, of course, the largest of the plants and animals are made up of many millions of cells.

1-2. **Structure.** In terms of structure, there is no such thing as a typical cell; cells come in many shapes and sizes. For example, some cells are too small to be seen with a light microscope, while others may be inches across. It is not necessary, for our purpose, to discuss the anatomy of each of the many kinds of cells, nor is it necessary to go into the complete anatomy of cells. We will, however, look at a few important structures that will enable us to better understand how cells function.

1-3. **Protoplasm.** Protoplasm is the living substance that makes up cells. This word isn't very specific because living material is composed of a wide variety of intricately organized substances. Protoplasm may best be regarded as a complex mixture of protein molecules, fat globules, inorganic salts, sugars, and amino acids in water.

1-4. There are two types of protoplasm: *cytoplasm* and *nucleoplasm*. Cytoplasm lies inside the cell membrane but outside the nucleus. Nucleoplasm is the protoplasm within the nucleus.

1-5. **Cell Membrane.** The cell membrane is a structure through which materials pass into and out of the cell. This membrane, like a strainer, is selective; that is, it will allow some materials to pass through, but will not allow the passage of others. The cell membrane is therefore said to be *semipermeable*.

1-6. **Cell Wall.** Plant cells have a rigid outermost layer called a cell wall. This structure, composed primarily of cellulose, gives the cell its rigidity.

1-7. **Nucleus.** The nucleus is usually the most obvious anatomical feature of a cell, standing out as a rounded body slightly denser than the surrounding cytoplasm. The nucleus contains chromatin, a complex material that is ultimately responsible for controlling all activity of the cell. Another function of the chromatin is carrying the inheritance factors of a cell, enabling the cell to pass its own special characteristics to its descendants.

1-8. **Vacuoles.** Membrane-enclosed, fluid-filled spaces called vacuoles are found in many types of cells. There are various kinds of vacuoles with a corresponding variety of functions. One example is the food storage vacuole. Another type, found in some one-celled organisms, is responsible for expelling excess water from the cell.

1-9. **Plastids.** The type of plastids of greatest importance to us in our discussion of cells is that which stores pigments, such as chlorophyl, used in carrying out photosynthesis. Within these plastids, energy from the sunlight is trapped and used to produce food for the cells.

1-10. **Mitochondria.** Mitochondria are sometimes referred to as the powerhouses of the cell. These oval-shaped structures, found throughout the cytoplasm, have been shown to be the site of the greatest amount of metabolic activity within the cell. They break certain organic compounds down into carbon dioxide and water, releasing energy in the process.

2. Bacteriology

2-1. **Bacteria.** Bacteria are tiny, single-celled organisms that resemble plants in that they have a rigid cell wall. Bacteria are unlike plants in that they have neither chlorophyl nor organized, well-defined nuclei. Since they lack chlorophyl, and subsequently lack photosynthetic activity, they must absorb food from their environment. The chromatin, though not organized into a definite nucleus, does function much the same as chromatin in other cells. Figure 1 shows that bacterial cells occur in a number of shapes: round, called cocci; oval (or elongated into rods), called bacilli; and a third group of bacteria are shaped like little coil springs and are called spirochetes or spirilla. The shape of a particular bacterium is one of the main criteria used in its identification.

2-2. Another major factor in identification is the way the cells are arranged or grouped together. An arrangement grouped in clusters like grapes is called staphylo. Therefore, round bacteria (cocci) that appear in clusters are called staphylococci. Some cocci arrange themselves into pairs. Paired organisms are called diplo, thus the term "diplococci." Still another group of cocci forms into long chains. These organisms are known as streptococci. The bacillus organisms, or rod-shaped bacteria, may align themselves into chains or pairs, and these are called streptobacilli or diplobacilli; however, these terms are not often used. The spirochetes vary from a loose spiral to a tightly coiled spring. They may be short or very long. They always appear as individual cells and do not form clusters or chains.

2-3. The pairing, chaining, or clustering of bacterial cells is a result of the organism's method of reproduction. The cells multiply by a process called binary fission (fission is to split; binary means "two"). One organism splits into two organisms just like the parent cell.

2-4. In addition to different shapes and groupings, some bacteria have special structures that aid in motility or survival in nature. Many bacteria possess an outer coating known as a capsule. The capsule may be so thin that it is undetectable. Others have a very thick, sticky capsule composed of a complex sugar-fat-protein substance. It is believed that this capsule aids in the organism's defense against the white blood cells in the body, and possibly some other hazards the cell may encounter in nature. To enable them to move about, some of the bacilli have special structures called flagella. A flagellum is a hairlike appendage that whips back and forth and either pulls or pushes the organism about. Some cells have a single flagellum on one end. Others have one on each end. Still others have several flagella on one or both ends, while still others may be completely covered with flagella. The sole purpose of the flagella is to provide a means of movement.

2-5. Another of the special structures that develop in certain bacteria is the spore. Any time these organisms find themselves in an unfavorable environment, they concentrate their protoplasm into a little round ball (the spore) and become extremely resistant to the unfavorable condition. When the spore is formed, you can clearly see the rigid cell wall with the little round ball inside. This spore formation enables the organism to survive conditions that normally destroy bacteria. One species, *Bacillus anthracis*, has been known to live for as long as 40 years outside of the animal body, and some organisms can withstand boiling for as long as 2 hours.

2-6. **The Gram Stain.** Bacteria, because of their small size, are difficult to see even with a good microscope unless they are properly stained. They may be stained with almost any aniline dye, but the most common staining reaction used in bacteriology is the *Gram stain procedure*. It is used because it differentiates between two major groups of bacteria. Almost all bacteria may be placed in one of two groups: Gram-positive or Gram-negative. Those organisms that are Gram-positive have a substance in their protoplasm known as magnesium ribonucleate. The presence of this substance is determined by the Gram-staining reaction. The organisms are first stained with crystal violet stain, which unites with the ribonucleate. Next they are placed in an iodine solution. The iodine serves as a mordant or fixative that causes the crystal violet stain to become fixed to the ribonucleate substance. Ethyl alcohol is then flowed over the slide and the "unfixed" stain is washed away. Naturally, if the ribonucleate substance is not present, all the crystal violet stain is washed away. If ribonucleate is present, the fixed portion of the stain remains in the organism. After the alcohol destaining process, the organisms are subjected to a secondary stain which is usually safranine red. Any stain will suffice as long as it contrasts well with crystal violet. Those organisms with the ribonucleate substance are blue or violet and are Gram-positive, while those without ribonucleate stain red and are Gram-negative. Thus the Gram stain procedure not only stains the bacterial cell so that it may be seen, but also aids in its identification by placing it into one of two major categories.

2-7. **Cultivating Bacteria.** It is almost impossible to study or identify a single bacterial cell. Therefore, we grow or culture bacteria in the laboratory under controlled conditions. Bacteria are cultured by plating them into a nutrient substance at a temperature that meets their environmental requirements. This substance is called a *culture medium*. It must contain the nutritional requirements and proper moisture, and have sufficient buffers in it to eliminate some of the waste

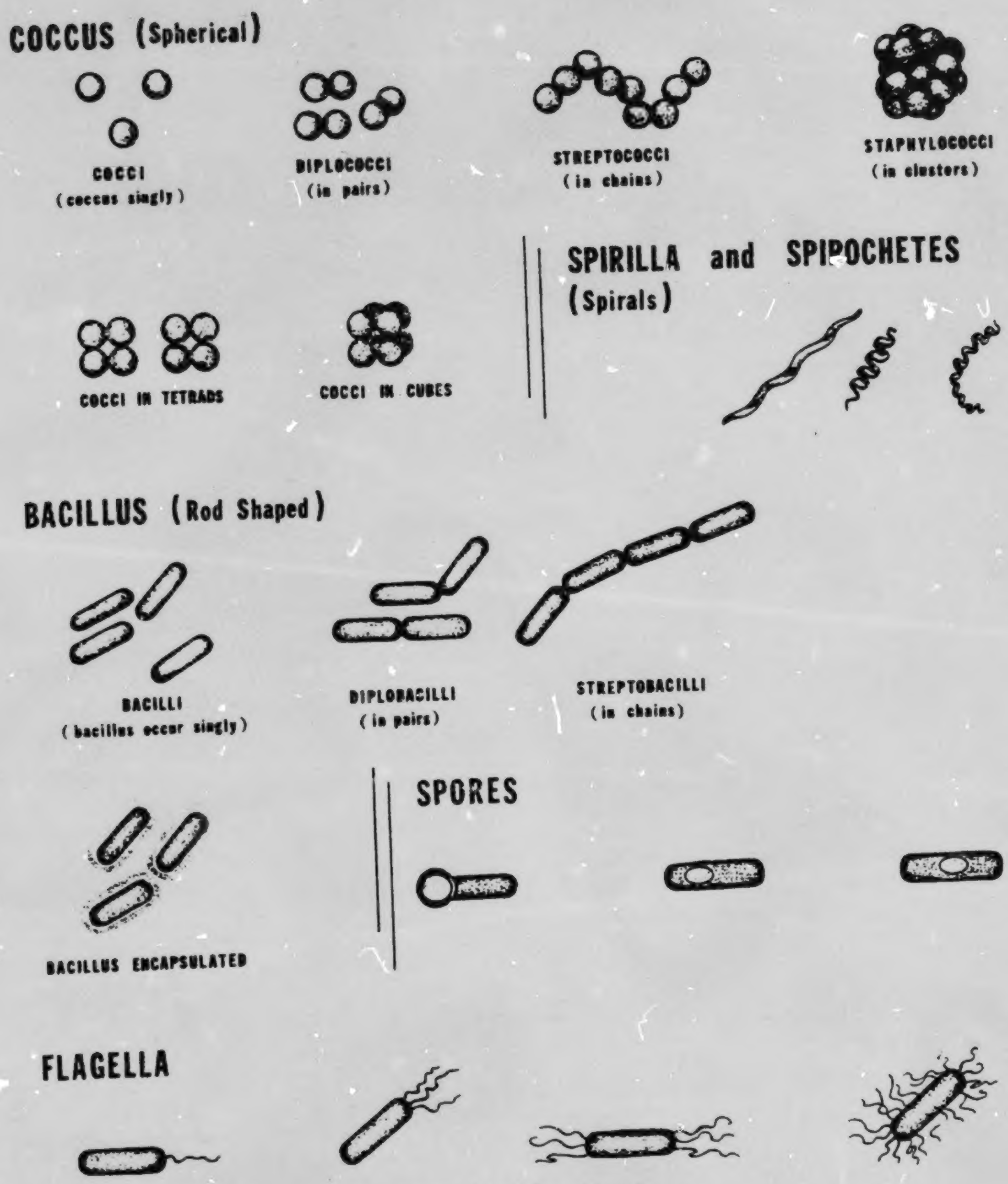
COCCUS (Spherical)
COCCI
(coccus singly)
DIPLOCOCCI
(in pairs)
STREPTOCOCCI
(in chains)
STAPHYLOCOCCI
(in clusters)
COCCI IN TETRADS
COCCI IN CUBES
SPIRILLA and SPIROCHETES
(Spirals)
BACILLUS (Rod Shaped)
BACILLI
(bacillus occur singly)
DIPLOBACILLI
(in pairs)
STREPTOBACILLI
(in chains)
BACILLUS ENCAPSULATED
SPORES
FLAGELLA

Figure 1. Morphology of bacteria.

products produced by the bacteria. If all the nutritional and environmental requirements are met, the organisms reproduce, some of them as often as every 15 minutes. The organisms continue to grow and reproduce as long as the conditions remain favorable. If the culture medium is a clear liquid, the growth is obvious after a few hours. The liquid becomes cloudy. If the medium is a semisolid, the organisms grow into a visible colony and may look like those shown in figure 2. The characteristics of the colony are noted and are major factors used in the identification of the organisms.

2-8. *Selective media.* We may add certain chemicals to culture media that allow some bacteria

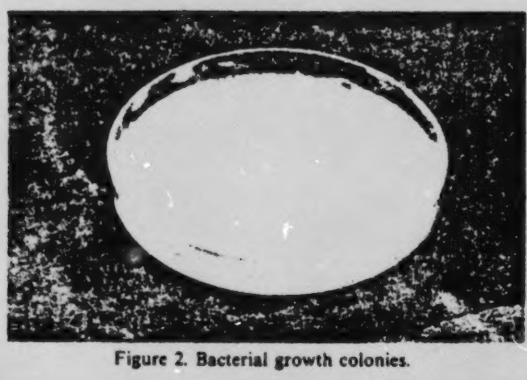

Figure 2. Bacterial growth colonies.

to grow and inhibit the growth of others. One chemical additive is NaCl (table salt). While some organisms grow well in high concentrations of NaCl, others cannot grow at all. This is also a factor in an organism's identification. These chemical additives are called inhibitors. When they are added to a culture medium, the medium is called an inhibitory medium or a selective medium—meaning that it will sustain the growth of only select organisms.

2-9. *Differential media.* Other media contain chemicals that cause the bacteria to produce specific colors in the media or in the colony itself. These are known as differential media. Media production has become so well developed, is so selective, and so differentiating that most pathogenic bacteria can be placed in specific groups and some can be completely identified by the use of culture media and the Gram stain alone.

2-10. **Environmental Requirements.** We can expect to find almost as many different environmental requirements as there are different kinds of bacteria. A particular bacterium, in order to reproduce or grow, must have the proper temperature, nutritional requirements, moisture, and pH. To all of these we must add the oxygen requirements. We will discuss these environmental requirements in general, without being concerned about specific organisms. We will, however, show how these factors relate to the problems of food spoilage and food establishment sanitation.

2-11. *Temperature.* Temperature is a very critical requirement for bacteria, so much so that they are classified according to their optimum growth temperatures. The classifications of bacteria according to their temperature requirements are:

a. Psychrophilic—Cold-loving.
b. Mesophilic—Medium temperature-loving.
c. Thermophilic—Heat-loving.

2-12. Psychrophiles, the cold-loving bacteria, grow in temperatures from 32° F. to 86° F. They grow best at about 68° F. These bacteria, when present in food, cause undesirable flavors to develop and decrease keeping qualities. The presence of psychrophilic bacteria in milk, after pasteurization and cooling, indicates poor sanitation during processing.

2-13. Mesophiles are those organisms that require temperatures close to body temperature. Mesophiles grow in a temperature range of 50° F. to 113° F. They grow best between 90° F. to 113° F., with normal body temperature (98° F.) the ideal. From a public health viewpoint, mesophiles are of particular importance because all known pathogenic bacteria fall into this group.

2-14. Food should not be kept at temperatures that support the growth of mesophiles. Some pathogenic bacteria grow quite well in certain foods and, in turn, cause food-borne illnesses in humans. As you will see in later chapters, great importance is placed on not allowing foods to be maintained at temperatures within the "danger range" of 40° F. to 140° F., and certainly not for more than 4 hours. This is long enough for bacteria to produce enough toxins, or to reach sufficient numbers, to make the food dangerous to eat.

2-15. Thermophilic bacteria are not known to be pathogenic. They grow at high temperatures (104° F. to 164° F.). Their optimum growing temperatures are from 122° F. to 131° F. You will find that thermophiles usually appear as "pinpoint" colonies on plates incubated at standard plate-count temperatures (89° F. to 97° F.), because these incubation temperatures are below the optimum for the thermophiles.

2-16. *Nutrients.* Since a bacterium has no mouth and absorbs its food directly through its cell membrane, its food must be part of its environment. Different kinds of bacterial organisms have different nutritional requirements, so you can begin to see why some bacteria are found in one substance, while other organisms are found in another substance.

2-17. *Moisture.* Bacteria require moisture to mulitply and grow; in fact, to stay alive. This is an important fact that is utilized in food preservation. Foods are dried in a variety of ways, all of which remove available moisture and prevent the growth of bacteria. It is usually bacterial growth in food that results in spoilage; by preventing the growth of bacteria, this type of food spoilage is also prevented.

2-18. *pH.* Another important factor in the growth of bacteria is the pH (concentration of acid or base) of the environment. Each type of bacteria has a specified pH at which its growth is optimal. This is another factor that is used in food preservation. Susceptible foods are often protected by being made more acid, thus making them incapable of supporting the growth of most bacteria.

2-19. *Oxygen.* Different microorganisms have different oxygen requirements. Some organisms use atmospheric oxygen and are called *aerobic* organisms. *Anaerobic* organisms require an environment where there is no air or free oxygen. *Facultative* organisms are able to live under either aerobic or anaerobic conditions.

2-20. **Toxin Production.** As the organisms grow, they produce waste products and sometimes excrete other substances used in digestion. These products may be poisonous to us; if so, we call them *toxins*. Toxins produced by living organisms are called exotoxins. As bacteria die and break up, some of them release toxins from inside the cell, and these are called endotoxins. In either case, these are the substances that make bacteria harmful. Organisms may produce endotoxins or exotoxins that have a direct effect on the cells of your body, or they may infect a food substance and contaminate it with toxins. When we eat the food substance, the toxins are absorbed and poison our bodies. Some of these toxins are destroyed by heat and are known as thermolabile. Some toxins are not affected by heat and are called thermostable. Cooking the food may kill the bacteria but does not necessarily make it safe to eat.

3. Fungi, Protozoans, Viruses, and Rickettsiae

3-1. There are simple forms of plant and animal life you will be concerned with in your work. It is important to remember that some of them are beneficial, and some of them are destructive to man and animal.

3-2. **Fungi.** The fungi make up an extremely large group of plants containing thousands of parasitic and saprophytic species. Some are parasites of animals, including man; many skin diseases, such as ringworm and athlete's foot, are caused by fungi. Other fungi cause the spoilage of bread, fruits, vegetables, and other food stuffs.

3-3. Not all economically important fungi are pathogenic or destructive; many are beneficial to man. Yeasts (single-celled fungi) are used in the manufacture of alcohols, cheeses, and some antibiotics. You should also be familiar with the role of yeast in the production of breads and other bakery goods.

3-4. The fungi of primary importance to us are the yeasts and molds. They have no roots, stems, or leaves, and no chlorophyll. Without chlorophyll they cannot produce their own food; therefore, they must depend upon some other food source—such as dead or decaying matter, a manufactured food product, or a living organism.

3-5. Fungi reproduce sexually or asexually. The asexual method is known as budding. A portion of the cell swells to a certain size, then seems to pinch off from the parent cell. Yeasts reproduce in this manner. In sexual reproduction the cells branch and form male and female reproductive cells which unite and cause the production of spores. These spores contain all the ingredients necessary to produce another colony. Molds produce several types of asexual spores, one of which is shown in figure 3. Note the different appearance of the conidiophores of the three genera illustrated, *Aspergillus*, *Penicillium*, and *Hormodendrum*. Some fungi are capable of both sexual and asexual reproduction.

3-6. *Yeasts.* The yeasts are round or oval and are much larger than bacteria. They have a large vacuole that takes up a good portion of the cell—usually there are a few large granules between the vacuole and the cell wall. The internal characteristics are of no importance in their identification, because their identification is based almost entirely on the type of colony the yeast produces. The colony may be rough or smooth; its margins may be entire (unbroken) or irregular. It may appear dry or moist, and it may be any color in the spectrum. Some consideration is given to the nutritional and environmental requirements of the

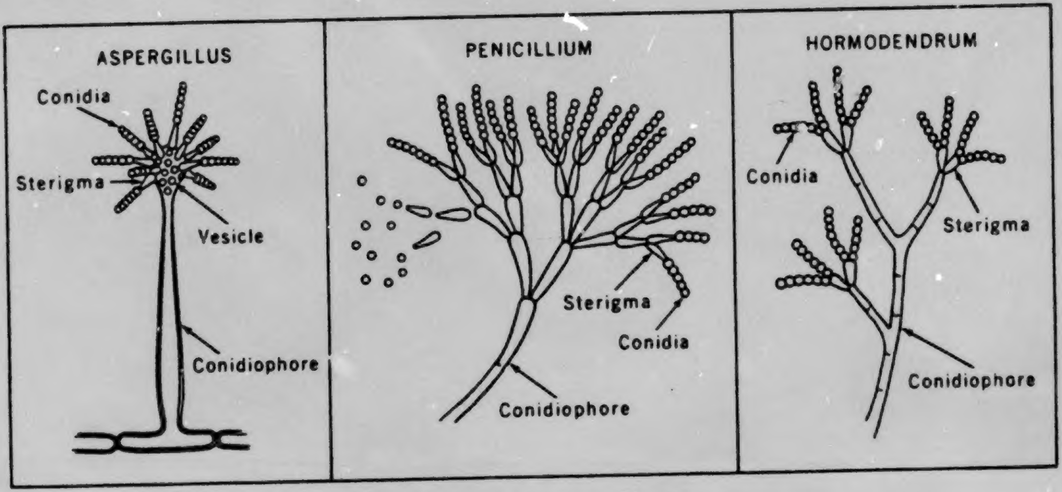

Figure 3. Asexual spores (conidia) are produced at the tips of fertile hyphae.

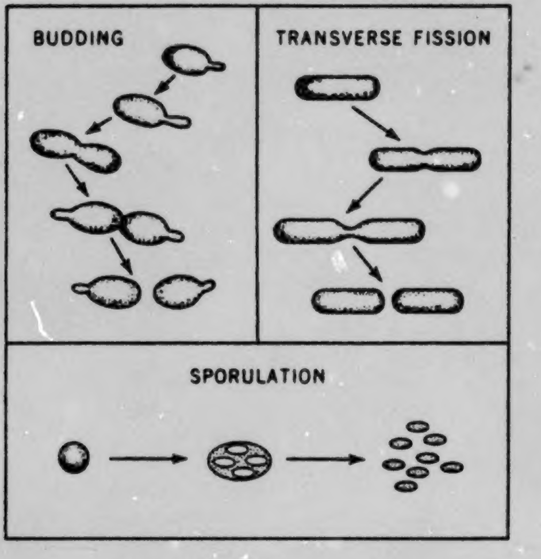

Figure 4. Reproduction of yeasts.

fungus; however, these factors are not nearly as critical as with bacteria. Yeasts reproduce asexually (by budding, by transverse fission, or by sporulation) or sexually. The three asexual methods are shown diagrammatically in figure 4.

3-7. *Molds.* As the molds grow, they produce flowery looking colonies of many colors. If you look very closely at one of these colonies, you will see many hairlike structures called hyphae (hi fee). After a period of time, you will discover little beadlike or podlike objects associated with the hyphae. These "objects" are spores or packets of spores. Some other morphological characteristics of fungi are summarized below. *Stolons* are hyphae-connected nodes from which other hyphae and *rhizoids* arise. Rhizoids are rootlike filaments that arise at nodes and attach to the substrate. They are found in *Rhizopus nigricans.* This particular fungus, as shown in figure 5, forms rootlike hyphae (rhizoids), vegatative hyphae that penetrate the substrate, and fertile hyphae that produce sporangia at the tips of sporangiophores (spore-producing hyphae). Stolons are rootlike filaments which connect individual plants. You can learn to recognize some of the more common molds at a glance, but it is best to leave the identification to a qualified laboratory.

3-8. Fungi are very difficult to control. Spores are found on everything; they blow around in the air and can grow on almost anything that hints at being a food substance. Some fungi even grow on wet wood or paper. Temperature variation doesn't seem to be too vital to them, though different temperatures change some of the colony characteristics. In some cases, a fungus will develop as a yeast at one temperature and as a mold at another temperature. Because of their prevalence in nature and their association with diseases, food spoilage, and industrial uses in food and medicine production, they are of prime concern to the veterinary service.

3-9. **Protozoa.** The protozoa are the simplest form of animal life. A protozoan is defined as a one-celled animal. To be more specific, "proto" means the first—or the precursor to—the first form of something, as prototype. "Zoa" is a combining form to designate animal. In other words, a protozoan is the first or most basic form of animal life. There are many different species of protozoa that are free-living in rivers, lakes, and ponds, but the protozoa you will be concerned with are those of medical importance.

3-10. Protozoa have some specialized structures that were not covered in our discussion of typical cells. Some of them have flagella or cilia that are

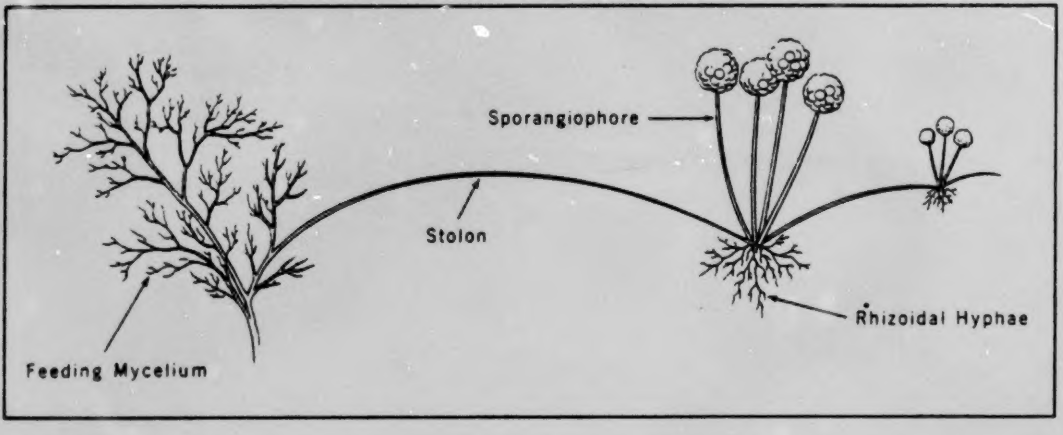

Figure 5. *Rhizopus nigricans* (the common bread mold).

organellae of locomotion. Some have a cytostome, which is a kind of primitive mouth. Others have a structure that is basically a primitive excretory organelle. (An organelle is an organ or part of a cell with a special function.)

3-11. Rarely will you be called upon to identify protozoa in your work as a veterinary specialist. There are many human diseases that are caused by protozoa, but these organisms are of little importance in the area of veterinary science in the military service; therefore, we will not discuss them further. There are protozoa that are responsible for diseases in dogs and cats; these are of importance to you and will be discussed in a later chapter.

3-12. **Viruses.** There is still another disease-causing entity that we have not yet covered. These are ultramicroscopic agents called viruses. In the past few years, vast amounts of knowledge have been gathered about them, but they are still a mystery to people outside the field of virology. They are so different from the other disease-causing agents that they cannot be compared with any of them. They are not known to be plants or animals and only a few can be seen with an ordinary microscope. They do not fit our present biological definition of "living" organisms, nor do they die. They merely inactivate or disassociate themselves. They do not reproduce themselves, but cause a living cell to replicate or reproduce them. They cause a wide variety of diseases, some of which are sponatic, in plants, animals, and man. We will cover some of these in a later chapter.

3-13. **Rickettsiae.** Rickettsiae are obligate (oxygen is toxic to them), intracellular parasites of such arthropods as fleas, lice, mites, and ticks. Several of them are pathogenic for man and other mammals. Transmission occurs through bites or in the excreta of the arthropod vector. Their exact nature is not known, but they are thought to be intermediate between bacteria and viruses because they have features of both. Rickettsiae do *not* form spores, they are not motile, and are readily destroyed by heat, dehydration, or simple antiseptics. The pathogenic rickettsiae are placed in the following five groups: *typhus, spotted-fever, tsutsugamushi, Q-fever,* and *Rickettsial pox.* In addition, there are rickettsiae that cause communicable diseases of the bovine (cattle), the ovine (sheep), and the caprine (goat) species.

4. Disinfection and Sterilization

4-1. Now that you have a basic understanding of microorganisms, we should devote some time to methods of destroying them. Two methods, disinfection and sterilization, will be discussed here.

4-2. **Disinfection.** Disinfection is killing or removing the microorganisms that could cause infection. Disinfection is normally accomplished by chemicals, such as phenol (carbolic acid), chlorine, or iodine. In milk, disinfection is accomplished by pasteurization, a heat process you will study in a later chapter.

4-3. **Sterilization.** To sterilize something is to rid it of *all* living microorganisms. Pay particular attention to the word *all*, because we are concerned with more than just the disease-causing organisms. Sterilization can be effected by any of three different methods: heat, mechanical means, and chemical means. Each of these can be divided into more specific methods. We will discuss each of these methods and show you how they may be used.

4-4. *Heat.* Heat sterilization may be accomplished by direct flame, dry hot air, or moist hot air. Without a doubt, direct flame applied to the microorganism is the most effective, though this is not always practical. There are very few items that can be sterilized in this manner. A bacteriologist may "flame" a loop or a piece of glassware, but you cannot expose liquids, plastics, rubber, or fabrics to fire without destroying them. An object can be sterilized by direct flame only if it can be heated to incandescence without causing damage. Size is also a limiting factor here, so, once again, it is not too practical a method.

4-5. Dry hot air is satisfactory for sterilizing such items as glassware and metals. Then, of course, the items must be protected from becoming recontaminated before they are used. All items must be wrapped in heavy paper or other suitable covering and tied with string, then placed in a hot air oven at 338° F. for 2 hours. This method is not satisfactory for such items as liquids, plastics, rubber, and fabric for the same reason that direct flame cannot be used. It's just too hot, so the moist hot air method has been devised.

4-6. True enough, boiling water does not sterilize, but if you apply pressure to steam, you can raise it above the boiling temperature of water (212° F.). This becomes a very effective way to sterilize almost anything. Objects are first wrapped or covered securely to prevent contamination. In the case of liquids in sealable containers, the tops or seals must be loose to allow the steam to enter. The objects are then placed in an autoclave and exposed to live steam under pressure. Naturally the higher the pressure, the greater the temperature. After much experimenting it has been found that 250° F. at 15 pounds of pressure per square inch for 15 to 20 minutes is sufficient to kill all microorganisms. But, remember, you should not place anything in an autoclave that would be harmed by moisture, pressure, or increased temperature. The autoclave is the most common means of sterilization today.

4-7. *Mechanical.* This method is by filtration and naturally is confined to liquids. It is desirable in the sterilization of solutions of sugars, tissue extracts, etc., where extreme heat could have a damaging effect, such as the caramelization of sugar. The solution is forced through a filter into a closed sterile container. There are a number of ceramic filters available, with known densities. These are used once, then thrown away. Because the pore sizes are so small, the fluid must be forced through them. This is done by drawing a vacuum in the sterile container that will catch the fluid or by applying a positive pressure to the unsterile fluid. Either way is effective, but it is more desirable to use pressure with viscous fluids, such as serum, to avoid foaming on the sterile side of the filter. The most important thing to remember is that the container and filter must be presterilized before use.

4-8. *Chemical.* This is most applicable to large surface objects, such as tabletops, floors, etc. There are three terms you should be familiar with that apply to chemical sterilization. They are "germicide," "disinfectant," and "antiseptic." A germicide (germ—microbe, and cide—to kill) is a solution that will kill all bacteria. It is effective if it is used in the proper strength and as directed by the manufacturer. The word "disinfect" means to kill the infectious organisms; a disinfectant solution does not kill all bacteria. It rids an object only of the pathogens and, even then, many spores remain. An antiseptic solution does not necessarily kill bacteria. It only renders them incapable of reproduction, and it doesn't always work. Never assume something is sterile because it has been cleaned with an antiseptic. Never try to substitute one chemical solution for another, and keep in mind that, as the chemical solution dries, it leaves a residue that can be harmful in some instances.

5. The Microscope

5-1. In historical perspective, one may say that during the 17th century the microscope opened up the "microcosmos" (the world of small things), whereas the telescope opened up the "macrocosmos" (universe). Scientists from many lands made contributions to reveal these phenomena and dimensions.

5-2. **Operation.** Figure 6 shows the compound microscope that is common to most, if not all, veterinary facilities. Locate this figure now and refer to it as we continue.

5-3. The microscope is primarily used to observe objects too small to be seen by the naked eye. Any object this small naturally must be held or mounted. Glass slides are used for this purpose. When examining such slides, take the following steps:

a. Use the coarse adjustment knob to raise the body tube.

b. Place the slide on the stage. Select the objective to be used and turn it into line with the oculars by revolving the nosepiece. When revolving the nosepiece, observe closely to assure that objectives do not come into contact with the slide or other objects.

c. While observing from the side, lower the objective with the coarse adjustment knob until the objective is very close to the slide. When using the oil immersion objective, lower it until it enters the oil.

d. Look through the oculars, and slowly *raise* the objective by turning the coarse adjustment knob until the field comes into view. *Never* move an objective downward while looking through the ocular, because it can damage the lens of the objective or the slide.

e. Use the fine adjustment to get the best possible focus.

f. Adjust the mirror and/or light.

5-4. **Precautions.** A few very important precautions you should always observe in caring for your microscope are as follows:

a. Always cover the microscope when you are not using it.

b. Take care to prevent any parts of the microscope from coming into contact with substances that might corrode metal, damage the lenses, or dissolve the cementing substances with which the lenses are secured into the objective and oculars.

c. Use only lens paper to wipe the lenses. Never touch the lenses with your fingers because even slight amounts of perspiration can damage them. Xylol is the only agent that should be used in cleaning the lenses or in removing oil from the objectives.

d. Protect the microscope against direct sunlight and moisture.

e. After using, always turn the nosepiece into a position that brings the low power objective directly over the opening in the stage. This may prevent accidental damage to the objective.

5-5. There are various types of microscopes. They range from the single lens, which is nothing more than a simple magnifying glass, to the very complex and complicated electron microscope. All microscopes are not operated in the same manner, nor do they require the same care. Therefore, before attempting to use a microscope, take the time to familiarize yourself with the parts, functions, and the care required for that particular instrument.

6. Laboratory Specimens

6-1. **Collection and Submission.** The most common error made by veterinary personnel in collecting and submitting laboratory specimens is improper labeling and packaging. We cannot emphasize too much the importance of:

(1) Labeling your specimens so there can be no doubt about their identification when they reach the lab.

(2) Using proper and adequate containers. (For example, if your specimen is a liquid, don't assume the container you're placing it in is leak-proof; be

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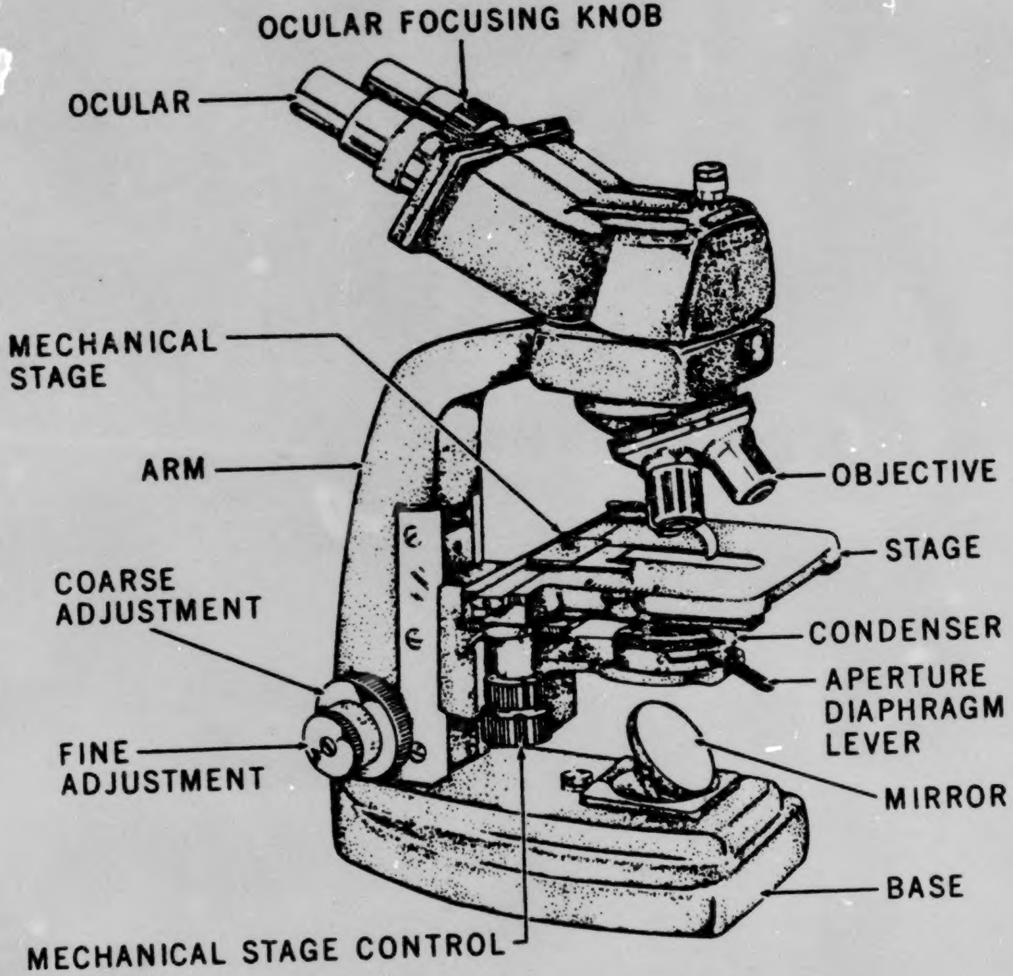
OCULAR FOCUSING KNOB
OCULAR
MECHANICAL STAGE
ARM
OBJECTIVE
STAGE
COARSE ADJUSTMENT
CONDENSER
APERTURE DIAPHRAGM LEVER
FINE ADJUSTMENT
MIRROR
BASE
MECHANICAL STAGE CONTROL

Figure 6. Parts of the compound microscope.

certain. Or if the specimen requires a sterile container, it is essential that you make certain not only that it is sterile but that it is kept sterile when you are collecting your specimen.)

(3) Using proper and adequate preservatives, and keeping your specimens at the proper temperature before packaging.

(4) Making certain that your specimens are securely packaged and properly addressed. If the specimen is lost or delayed in mailing, or the primary container is broken or crushed, all of your other painstaking preparations were in vain.

6-2. While we are on the subject, look at table 1, which is an excellent guide for preparing specimens for submission to the laboratory. Read this table carefully and conscientiously, and it will most certainly increase your knowledge in this area. We must point out, however, that it is only a guide, because laboratories vary in their instructions. You may have specific instructions from the laboratory in your area that conflict with those in this table. If you do, of course you must follow your laboratory's instructions.

6-3. Now that you have read table 1 carefully, you have discovered that not all of the specimens you may need to collect and submit to the laboratory are included. Such a table would be nearly impossible to compile and would most

TABLE 1

GENERAL INSTRUCTIONS FOR SUBMISSION OF LABORATORY SAMPLES

SPECIMEN AND TYPE OF ANALYSIS	AMOUNT	INSTRUCTIONS
Bottled fluid dairy products, fresh (includes samples in paper container)	Unopened container (½ pint minimum)	Samples will be submitted in original unopened containers, packed in cracked ice (not dry ice), so that the container remains in an upright position and no liquid reaches the lid or cap. Samples will be delivered to the laboratory as rapidly as is practicable, within 4 hours of the suggested maximum expiration of time between collection and delivery. Temperature of sample should not exceed 40° F.
Bread Chemical	Minimum of 3 slices	Sample should be packed in a sealed plastic bag and placed in a protective outer container or be submitted as an entire unopened loaf.
Bulk fluid and frozen dairy products, fresh Bacteriological, chemical and/or microscopic	Minimum of 200 ml in sterile container (6640–408–9195)	Fluid samples will be treated as bottled fluid dairy products above and frozen desserts will be treated as packaged frozen desserts below.
Butter Bacteriological, chemical and/or microscopic	1 pound in original container or sealed plastic bags.	Samples shall be refrigerated, if submitted during warm weather, and no moisture allowed to enter sample container. If mailed, container 8115–682–6525 will be utilized.
Cheese, natural and process Chemical	½ pound in original container inside of sealed plastic bag	Do not add a preservative. Sample may be shipped unrefrigerated or packed in dry ice (preferred method during hot weather).
Cottage cheese Chemical	Minimum of a 10-gram sample	Submitted in original container or in container 6640–408–9195, or similar container, either refrigerated or preserved with formalin.
Dry milk Bacteriological and chemical	Original container or 1 pound in sterile container	A representative sample should be aseptically submitted to the laboratory.
Evaporated milk Bacteriological and chemical	Two cans from each lot	Packaged to prevent damage during transit.
Flour Chemical	Minimum of 50 grams in original container or container 6640–408–9195	Packaged to prevent damage during transit.
Fluid and frozen dairy products, preservative added Chemical and/or microscopic	Minimum of 120 ml in sterile container (6640–405–6400	A representative portion of the fluid sample will be used to completely fill the bottle. The frozen sample will be melted and a representative portion placed into the bottle. All bottles shall be checked prior to shipment to insure that no air bubbles are present. Presence of preservative and quantity must be noted on label. The preservative of choice is 1cc of 2% Merthiolate per 120 cc of fluid milk.
Beef, ground or boneless Chemical	1 pound in sealed plastic bag and outer mailing case	Collect portions at regular intervals, regrind with a meat grinder, mix well and place approximately 1 pound in airtight glass container or plastic bags. To prevent decompositon during warm weather, add 2 ml formalin per lb.
Animals suspected of rabies Biological	Entire brain	The head of a suspected rabid animal shall be delivered by messenger, whenever possible, or expressed to the laboratory. *Material from rabies suspect animals cannot be mailed under any conditions.*

TABLE 1 (Continued)

GENERAL INSTRUCTIONS FOR SUBMISSION OF LABORATORY SAMPLES

SPECIMEN AND TYPE OF ANALYSIS	AMOUNT	INSTRUCTIONS
		1. The head will be placed in a watertight container which is then placed inside a leakproof container. Sufficient ice should be placed around the inner container to prevent decomposition from occurring. Use sufficient water ice, depending on length of shipping time. The outer containers shall be labeled to indicate its dangerous contents. Shipments will be arranged with the Express Company so that they will not arrive at destination on Sundays.
Oleomargarin	1 pound in original carton or sealed plastic bag	Packaged to prevent damage in transit and if not submitted in original carton, shipped in container 8115-682-6525 for protection of bottle.
Oil, vegetable salad Chemical	One container or 250 ml	Packaged to prevent breakage in transit.
Sausage, bologna frankfurters, liverwurst, pork, and salami Chemical	1 pound or 6 links in sealed plastic bags	Sample will be submitted in a tightly sealed container and, if a preservative is necessary, 2 ml of formalin per lb of sample will be used.
Tomato puree Chemical	1 pint in original container or full container 6640-408-9195	Packaged to prevent breakage in transit.
Frozen dairy products, fresh, frozen Bacteriological, chemical and/or microscopic	Unopened container (½-pt minimum)	Samples will be submitted in original unopened container packaged in dry ice so that the specimens arrive frozen and any insulating material used does not contaminate the specimen.
Homogenized milk, frozen Bacterial, chemical and/or microscopic	Two unopened containers	Specimens will not be allowed to thaw during transit. Two specimens are needed for each sample submitted to enable both bacteriological and chemical analysis.
Lard and shortening Chemical	Minimum of 1 pound in unopened container or sealed plastic bag	Sample should be placed in the glass container tightly sealed and packaged in container 8115-682-6525. Metal containers should not be utilized unless submitted in original unopened container.
Mayonnaise and salad dressing Chemical	Minimum of 1 pint	Submit in unopened original container packed to prevent breakage.
Meat and noodles or meat and spaghetti Chemical	4 ounces in original container	Packaged to prevent breakage in transit.
Milk containers Bacteriological	Sealed container	Submit sealed refrigerated container within 4 hours of collection.

certainly be too large to include in this text. However, there are four other types of specimens that we should discuss briefly because of our responsibility in caring for Government-owned animals.

6-4. **Bacterial Specimens.** As you know, there are many bacteria and they are everywhere. When you collect specimens of animal tissue to submit to the lab for bacteriological analyses, be sure to use sterile instruments. The skin where you make the incision should be thoroughly disinfected. Remove the tissue using your best sterile technique. Place the specimen in a wide-mouth jar and keep it refrigerated until it is delivered to the laboratory.

6-5. **Histopathology Specimens.** Histopathology specimens are generally collected in blocks not more than 5/10 centimeter thick. You should then place them in a clean wide-mouth jar of 10 percent formalin. Allow the tissues to fix for 12 to 24 hours. Transfer the tissues to a clean polyethylene bag or other suitable container, such as a rubber condom containing 10 percent formalin. A word of caution—be certain you submit such specimens to the histopathology center designated for your base.

6-6. **Toxicological Specimens.** When poisoning is involved, select stomach contents, blood, liver, kidneys, urinary bladder, and parts of the intestines. Securely seal them in a polyethylene bag and preserve them by freezing. When submitting these specimens to the laboratory, pack them in a generous amount of dry ice to assure their arriving at the laboratory in a frozen state.

6-7. **Virus Specimens.** For viral studies, submit tissue specimens preserved in a sterile solution of 50 percent buffered saline and 50 percent glycerin, and packed in dry ice. Serum specimens should be frozen immediately and should remain frozen until they reach the laboratory. Before submitting these specimens, make certain you are sending them to a laboratory that has the capability of identifying viruses.

6-8. You may be required to submit other specimens to a laboratory for analysis. If so, don't guess at the proper technique or method of collection; be certain. In fact, you should consult the proper authority before submitting all specimens, to make sure that you comply with local or area laboratory requirements. Someone's life could well depend on the accuracy of the laboratory's analyses.

7. Laboratory Procedures

7-1. There are hundreds of tests that can be used for the analysis of food items. They fall primarily into two groups: chemical and bacteriological. The number and type of these tests run by base veterinary offices varies greatly throughout the Air Force. At one base you might be asked to perform many different tests, some of them rather complex. At another, you might just perform a few simple ones. In the latter case, you would no doubt be sending food samples to a laboratory, requesting that specific analyses be performed on them.

7-2. **Chemical Analyses.** Chemical tests are used to determine the presence of and/or concentration of chemical contaminants or additives in food, the percentage composition of certain primary ingredients, or the pH of certain food items. Many of these tests are performed by special laboratories which provide this service to Air Force veterinary offices. You should be familiar with some common tests that you might be called upon to perform.

7-3. Probably the greatest use of chemical tests in the veterinary service is in the analysis of certain properties of dairy products, such as acidity and specific gravity. Some of these will be covered in Volume 4. Not all chemical tests, however, are for dairy products. The following test is performed during the inspection of oysters.

7-4. *Factors that determine the pH of oyster liquor*. The acidity of oyster liquor (liquid in which they are packed) is tested to determine the quality of a shipment, lot, or container of shucked oysters (removed from the shell). Shucking does not kill oysters immediately. The time they stay alive *i.* Using a sterile 11-ml. pipette, transfer 11 ml. of the diluted sample from dilution bottle No. 2 to dilution bottle No. 3. Discard the pipette, replace the stopper, and shake the dilution bottle.

j. Using a sterile 1.1-ml. pipette, transfer 1 ml. from dilution bottle No. 2 to a sterile petri dish marked with sample number, date, and 1/100. Discard the pipette.

k. Using a sterile 1.1-ml. pipette, transfer 0.1 ml. from dilution bottle No. 3 to another petri dish marked with sample number, date and 1/1,000.

l. Transfer the remaining 1 ml. in the pipette used in step *k* to the third petri dish, marked with sample number, date, and 1/1,000. Discard the pipette.

m. Add about 10 to 12 ml. of liquefied agar (at 44° C. to 46° C.) to each plate. Pour dilution control No. 1, then the three milk dilution plates, and last the dilution controls, No. 2, and No. 3. This procedure will give a check on agar sterility before and after pouring the milk dilution plates. Before pouring each plate, sterilize the lip of the agar flask by exposing it to a flame.

n. Allow the agar in the petri dishes to solidify, invert them, and place them in an incubator at 32° C. or 35° C. for 48 hours plus or minus 3 hours.

o. Counting procedures. Select plates containing between 30 and 300 colonies and count all colonies, including those of pinpoint size. Multiply the number found by the dilution factor. Report as "____ colonies per ml. (____ samples)" or "____ colonies per gm." (ice cream and frozen desserts).

7-9. For counts on solid foods (meats or vegetables), weigh 50 gm. of sample into 450 ml. of sterile water in a sterile mechanical blender and blend for 2 minutes; then let the blended material stand for 2 minutes. Resuspend the sample and pipette an 11-ml. portion into 99 ml. of sterile water. Prepare and plate 1/100 and 1/1000 dilutions as described previously and incubate the plates for 3 to 4 days at 30° C. to 32° C; count all colonies and express as "____ colonies per gram."

MODIFICATIONS

Chapter 2 of this publication has (have) been deleted in adapting this material for inclusion in the "Trial Implementation of a Model System to Provide Military Curriculum Materials for Use in Vocational and Technical Education." Deleted material involves extensive use of military forms, procedures, systems, etc. and was not considered appropriate for use in vocational and technical education.

CHAPTER 3

Food Technology

MILITARY MISSIONS hinge upon the availability of wholesome food for troops. But much of the world's food is spoiled by microbes, or is contaminated or destroyed by insects, rats, and other vermin. So food preservation and other aspects of food technology are important to you.

2. In this chapter, you will learn to relate food technology to the performance of your tasks. We will discuss:

a. Purposes of food preservation.
b. Methods of preservation (drying, refrigeration, freezing, canning, radiation, fermentation, curing, and using food additives).
c. Packing and packaging materials.
d. Cold storage practices.
e. Dry storage practices.
f. Inspection of canned goods.

We will begin the chapter with a discussion of the specific aims of food preservation.

11. Purposes of Food Preservation

11-1. The military services enjoy several advantages from using preserved foods. For instance, such seasonal foods as strawberries are made available at any season of the year, at any worldwide base, surplus foods can be preserved for use in years of shortages, and properly preserved foods can be moved to geographical areas where these supplies are either short or nonexistent. Members of the armed forces enjoy the luxury of having meats, fruits, and vegetables in the freezing units or in cans on the dining hall pantry shelves. In order for this to continue, your knowledge and actions must help do these three things: (1) prevent the spoilage of food, (2) preserve its nutrients, and (3) prevent its contamination.

11-2. **Prevention of Spoilage.** The primary aim of food preservation is to prevent food spoilage. But what is spoilage? Food is considered spoiled when microorganisms and enzymes have broken down the organic material of its structures and have altered it to such an extent that discriminating people will not accept it for consumption. Yet foods considered as acceptable from a taste or esthetic standpoint may be harmful because of microbial, chemical, or radiological contamination, and this spoilage may not always be easily detected. Customs and eating habits influence food acceptability. For example, limburger cheese and aged beef are acceptable to some people, but are violently rejected by others. In meeting our food inspection responsibilities, we must consider not only the aspect of acceptability, as represented by the esthetic values of a food's appearance, taste, odor, and color, but we must give even greater emphasis to the identification of spoilage or contamination that may cause illness. Let's look at some significant factors affecting or causing spoilage.

11-3. *Food composition affects spoilage.* Dry storage foods (such as flour, sugar, cereals, and beans), which are physically inert, usually do not spoil unless contaminated by vermin, water, radioactivity, poisons, or chemicals. Semiperishable foods (such as potatoes, apples, and nuts), which contain water or volatile ingredients, may remain unspoiled for relatively long periods if they are properly stored. Because meats, milk, fish, poultry, fruits, vegetables, and eggs contain bacteria and their associated enzymes in a semiliquid environment, they are considered perishable and must be either processed or refrigerated for storage. Spoilage proceeds more rapidly in any food that has a relatively neutral pH or one that contains a high percentage of water along with medium to low amounts of sugar or salt. The chemical structure of the food is yet another factor that may either accelerate or decelerate food spoilage. However, this depends upon the combinations and nature of the food spoilage.

11-4. *Microorganisms cause spoilage.* Microorganisms are an important factor in food spoilage. The degree of spoilage and the rapidity with which they can cause it depend upon several environmental conditions, such as the temperature, oxygen availability, and humidity. When optimum conditions exist, microorganisms multiply very rapidly; thus spoilage occurs at a very rapid rate. The principle of food preservation is to produce an environment that is not conducive to the growth of the organisms present.

11-5. Bacterial decomposition of proteins results in the most undesirable changes in food quality. Usually it is protein breakdown that causes a cheesy or rancid odor, while the breakdown of carbohydrates produces a sour, gassy type of spoilage. The type of decomposition (and its related odor) results from the type of byproduct liberated by the organisms as they feed on the food nutrients. Bacteria convert protein into various nitrogenous compounds that have extremely obnoxious odors. With regard to fat, bacteria separate the fatty acids, and produce a variety of odors. Bacteria convert carbohydrates into both acids and carbon dioxide gas. In all of these instances, the decompositional reactions are affected by the presence of moisture, such environmental conditions as oxygen availability and amount of light, and by various chemical factors. Sometimes these latter factors hasten decomposition and in other cases they retard it.

11-6. To elaborate upon the mitigating factors in food spoilage, you might begin with moisture conditions. For instance, bacteria must have their food in a soluble form. By removing available moisture, you can control microbial growth. This can be done either by reducing the water content in the food product or by limiting its availability from outside sources. In the first situation, there are several choices in the method to be used. Sugar or salt may be added; this causes some of the water in the bacteria to be withdrawn, therefore making it unavailable to the bacteria. The food may be frozen, changing the water to a solid and, again, reducing its availability. In any case, you may reduce bacterial action if you can keep the moisture content below 10 to 15 percent. This percentage varies widely, depending upon the particular food product, the amount of nutrients in solution, the interactions of integral chemicals, and other environmental factors. Generally, yeasts require slightly less moisture than bacteria, while molds (fungi) require only a very small amount of moisture. Molds can often grow on a quite dry product if the humidity is high.

11-7. Let us consider further the application of salt or sugar to food products in an effort to control bacterial activity. Certain concentrations of either can control most if not all microbial growth. Some bacteria are adaptable, and may grow in saturated salt or sugar solutions. Generally, gram-negative bacteria are inhibited by an 8-percent or stronger salt concentration, while a few gram-positive types will grow in saturated salt solutions. Most disease-producing or pathogenic bacteria are inhibited by 15 percent or higher salt concentrations, and by 25 percent or higher sugar solutions. Molds, on the other hand, are resistant to higher concentrations of sugar, since they do not require water in the food itself but, rather, can extract it from the air. In such cases, molds use only the carbohydrate or sugar in the food product.

11-8. Generally, bacteria prefer foods whose acidity is nearly neutral; yeasts can tolerate slightly acid foods; molds can tolerate and grow in extremely acid foods. For example, milk, meat, and seafoods (pH 6.7 to 7.0) are most likely to be spoiled by bacteria. Fruit juices and other acid foods (pH 3.5 to 4.5) containing fermentable carbohydrate are more subject to yeast spoilage, since the acidity helps to prevent bacterial growth. Rhubarb, cranberries, and similar highly acid foods (pH 2.6 to 3.2) are more apt to be spoiled by molds, since this extremely acid pH usually prevents the growth of yeast and bacteria. Normally, pathogenic organisms do not grow in those foods with a pH lower than 4.5 and often die in foods with a pH below 4.5.

11-9. Temperature is an important environmental factor concerning spoilage by microorganisms, but don't be misled by the discussion of the danger range (45° F. to 140° F.) covered in the microbiology chapter of this CDC. Although it is true that disease-producing microorganisms grow best within this temperature range, other microorganisms responsible for food spoilage grow in foods at temperatures above and below, as well as within, the 45° F. to 140° F. range.

11-10. Relatively high environmental temperatures permit only the growth of thermophilic organisms. Thermophilic bacteria cause spoilage of milk held at high temperatures, and of canned goods cooled too slowly after processing. Thermophilic yeasts and molds are too few to present a special problem.

11-11. Bad tastes and odors develop in milk from the activity of psychrophilic organisms. Even at temperatures of 32° F. or slightly higher, molds grow in meats, eggs, cheese, fruits, and vegetables. Bacteria tolerant to low temperature usually grow slowly. Yet, if adequate moisture is present, bacterial slime may form on meats, eggs may rot, and poultry, fish, and milk spoil in a matter of days even when stored under refrigeration.

11-12. *Enzymes spoil food.* Bacteria produce enzymes that cause food spoilage; but generally, when we speak of enzymatic spoilage, we refer to the enzymes normally present in food rather than to those produced as a byproduct of bacterial spoilage. Enzymes are organic substances produced in cells. They are capable of inducing chemical changes in the substrate while remaining unchanged themselves (a substrate is a substance acted upon). Enzymes, like bacteria, are affected by such environmental factors as temperature, pH, and chemicals (including salts). Certain carbohydrate foods contain amylase, an enzyme that can change starches to sugar (for example, the enzymatic action that softens and sweetens Irish potatoes). Other enzymes found in living cells are called autolytic, which means that they act on the tissues of their food, and cause it to break down or spoil. Many enzymes can be controlled to perform useful functions, as in the case of the enzymes used to tenderize beef in the process of producing what is called "aged beef." In the processing of dehydrated foods, moisture is removed to a level whereby enzymes do not act on the fat and other ingredients. Unless the moisture content is well below 1 percent, unwanted changes will be produced in the food. However, such undesirable enzyme activity can frequently be prevented by other means, such as blanching or heating the product slightly or by adding acids to lower pH.

11-13. *Oxidation-caused spoilage*. Another cause of food spoilage is oxidation, a natural process in which oxygen combines with certain chemicals in the food and gives the food an undesirable flavor and color. The most noticeable spoilage that results from oxidation is associated with the rancidity of fats. Other oxidative spoilages that often go unnoticed are decreases in vitamin content, changes in flavor, and changes in color. Increases in temperature accelerate oxidation as do increases of air penetration or other enhancement of oxygen. Oxidation can be partially controlled (though not completely) in certain foods (fats, in particular) by adding chemicals called antioxidants. These work by preventing the combining of oxygen with the food components.

11-14. *Pathogenic food spoilage*. Most disease-producing organisms that grow in food do not noticeably affect its odor, color, flavor, or texture. An occasional notable exception occurs with *Clostridium botulinum*. These organisms produce a deadly poison and sometimes (but not always) result in invisible spoilage of the food as well. Though rare in commercially canned foods, many other preserved foods do contain living disease-producing organisms. Even though they are not spoiling the food nor growing, these disease-producing organisms live for some time. Then when the condition of the preserved food is altered to make the environment again acceptable to the pathogens, they resume activity and can cause illness. One good example of this is the salmonella organisms surviving in dried eggs. Once the dried eggs are reconstituted with water or milk, the organisms resume growth and are capable of causing outbreaks of salmonellosis.

11-15. *Chemical spoilage*. The most prevalent chemical reaction is that of an acid food reacting with the iron in the can causing a hydrogen swell. Highly acid foods, such as canned fruits, sauerkraut, etc, are the most likely to be affected by hydrogen swells. There are other lesser known types of chemical spoilage factors. One involves sulfur-containing foods (corn, for example) that turn black because of the reaction of the sulfur with iron of the can. Another fairly common occurrence is the chemical release of carbon dioxide (not related to bacterial growth) in canned syrups and molasses products; this causes the cans to bulge, yet the product is neither dangerous nor unacceptable from an edibility standpoint.

11-16. **Preservation of Nutrients.** So far we have stated that the primary aim of preserving food is to prevent spoilage. There are other secondary aims. The nutrients of the food must also be preserved. Included are carbohydrates, proteins, vitamins, and fats. Carbohydrates are attacked by molds, yeasts, and bacteria. Bacteria or enzymes decompose proteins. Heat, light, and oxygen tend to destroy vitamins and make fats rancid. The rate at which these nutrients are spoiled by bacteria, molds, yeasts, and enzymes is determined by the pH of the food, amount of moisture and free oxygen available, temperature, light, and chemicals added to the food.

11-17. **Prevention of Contamination.** Food contamination can occur before, during, and after processing. When fruits or vegetables are first harvested, their skins may already contain contaminants deposited by birds, insects, rodents, or other vermin. Furthermore, contamination may result from putting foods into unclean boxes, crates, or other containers. During the slaughter of an animal, its meat may be contaminated by the butchering tools or by the hands of employees. While fruits, vegetables, and meats are being processed, they can pick up additional contaminants, particularly if insects and rodents are not controlled or if other appropriate sanitation measures are not observed in the processing plant. After it has been processed, a food can be contaminated during transit or storage if rough handling causes its container to break or if the container is penetrated by insects, birds, rodents, or their excreta. Thus you see that the prevention of food contamination requires continual vigilance throughout its procurement, processing, shipment, and storage. This will become increasingly apparent to you as we discuss the various methods of food processing.

12. Methods of Preservation

12-1. Using all available knowledge of food spoilage factors, you can prolong the life of foods. You must also keep in mind that in preserving the item, you can change its odor, flavor, or appearance to the extent that the item is no longer desirable or usable. Although other methods of preserving foods also alter the item, the general public has learned to accept and enjoy the end result. Examples of items that have been changed because of being preserved and are then considered to be more acceptable than the fresh product are pickles, salt pork, sugar cured hams, and raisins. Our discussion of the various methods of preservation begins with drying.

12-2. **Drying.** Being largely water, foods are readily subject to spoilage, since bacteria, yeasts, molds, and enzymes are active in a moist medium. By removing water you can slow down or prevent spoilage. For example, few bacteria and yeasts will grow in food with a water content as low as 30 percent by weight. In a food with a water content of no more than 10 percent, most molds will not grow. With 1 percent water or less, the action of enzymes in food will be greatly retarded if not inactivated. The dehydration of foods, then, has a considerable effect upon their ability to resist spoilage.

12-3. Water is removed from food by these methods: atmospheric drying, vacuum drying, and freeze drying. Associated with each of these processes are such disadvantages as changes in the porosity, flavor, and color of the food. Because of changes in porosity, dried foods often take a long time to rehydrate. Because of the evaporation of certain volatile substances, the flavor of food may escape or may change during drying. Because of a combination of amino acids and the reducing sugars, fruits and some vegetables often darken when exposed to air during the drying process. To reduce darkening caused by drying, fruits are often treated with sulfur dioxide (sulfuring) or sodium bisulfite (sulfiting).

12-4. As well as having similar disadvantages, the different drying processes have many similar steps in processing (unit operations) that are common. Let's discuss these before we take up any of the individual drying processes.

12-5. *Steps in processing.* Included in the unit operations are washing, trimming, dividing, blanching, sulfuring, and packaging. First, fruits and vegetables are washed to remove contaminants and lower the load of microorganisms. This renders their preservation easier. Before eggs are shelled, and before various fruits are processed, they often are washed in a 0.5 to 2.0 percent lye water solution. The lye breaks down the waxy or fatty coating on the eggs or fruit and makes it much easier to remove soil. In the case of fruits, it also makes dehydration easier. Such products as wheat, oats, and other grains are not washed during processing since they are naturally dehydrated, and washing with water would only ruin the preservation process already accomplished.

12-6. Fruits, vegetables, and meats are trimmed to remove bruised, wilted, and other undesirable parts. The trimming process, especially if it is done manually, is always a possible source of contamination for foodstuffs.

12-7. After fruits and vegetables are trimmed, they are usually halved, sliced, or diced in preparation for drying. Cereal grains, however, are dried before they are divided, that is, ground into flour or meal. The dividing process, whether done manually or by machines, is another source of possible contamination.

12-8. To blanch means to expose to hot water. Blanching fruits and vegetables makes them easier to peel, cleans them, shrinks them by removing gas, and stops enzymatic action.

12-9. Sulfuring does not kill bacteria, but it does have a marked bacteriostatic effect, and as we have already pointed out, sulfuring also helps to reduce the darkening of foods caused by drying.

12-10. *Atmospheric drying.* Drying in the air is the oldest method of food preservation. Throughout many centuries foods were dried in the sun. Among these foods were the cereal grains, fruits, and meats (in the form of jerky). Atmospheric drying methods include sun drying, kiln drying, tunnel drying, drum drying, and spray drying.

12-11. Sun drying is our oldest method of preserving food. Since grains are not harvested until the sun has removed much of their moisture, they are, in effect, sun dried for preservation. Other foods are hung on racks or spread on trays so that they are directly exposed to the sun. Dried apricots, peaches, plums, and grapes are produced by this method. The moisture content is reduced to 18-24 percent. Since this method of drying is subject to the whims of the weather, we have no positive control over the process. Furthermore, sun drying exposes foods to possible contamination.

12-12. In kiln drying, foodstuff is placed on slotted or perforated floors above a source of heat in a room called a kiln. Potatoes and apples are dried in this way. The moisture content is reduced 18–24 percent.

12-13. Tunnel drying takes place in a tunnel about 35 to 40 feet long and 6 feet wide. The foodstuff is placed in trays, which are stacked on trucks or on meshed conveyor belts at the tunnel entrance. As the trucks or belts move slowly through the tunnel, forced hot air is applied. The moisture content is reduced 7–8 percent. This method is used to dry fruits and vegetables.

12-14. Drum drying is used for liquid foods that have the consistency of puree. It is spread in a thin layer over the surface of a heated, revolving drum. When dried, the food is scraped off the drum with a blade. The drum may or may not be enclosed in a vacuum chamber to reduce the drying time. Foods dried by this method include milk, fruit juices, and certain vegetable purees.

12-15. Spray drying is the most efficient method of dehydrating liquids. Foods in the form of solutions or suspensions are atomized into a stream of heated air. This method is used to dry milk and eggs. It reduces the moisture content to as low as 2 percent.

12-16. *Vacuum drying.* Low heat applied in a partial vacuum is used for drying foods that would be damaged by high processing temperatures. In this process the food is exposed to a relatively low heat in a closed chamber under reduced pressure.

Included in the foods dried by this method are soluble coffee, fruit juices, and milk.

12-17. *Freeze drying.* In the freeze-drying process, the foodstuff is quick-frozen and the resulting ice is transformed into water vapor by sublimation (a process of converting water in the solid state to water vapor without its passing through the liquid state). Sublimation is produced by the proper control of temperature and pressure during freeze drying. The steps included in freeze drying are freezing, vacuumizing and heating, removing vapor, breaking the vacuum, and packaging.

12-18. The quick-freezing technique that freezes the product occurs in a range from 0° C. to 5° C. in less than 2 hours. Meat items frozen by this process should not be over 1/2 inch thick. After the product is frozen solid, it is placed in a chamber that is vacuumized and heated to remove the moisture.

12-19. As we previously mentioned, freeze drying is done through sublimation. This is the point where ice changes to steam. Sublimation occurs when the temperature is 212° F. at an absolute pressure of one atmosphere, which is boiling at sea level. Under less pressure, as in a vacuum chamber or at high altitudes, less heat is required to accomplish the same process. The actual temperature used in freeze drying is determined by the temperature that the food can tolerate without being burnt or damaged. The temperature/pressure combination at which sublimation occurs is not easy to obtain for it must be within the piece of food that is being dried rather than only in the atmosphere surrounding the food.

12-20. Heat sources for freeze drying include steam coils, steam-heated platens, infrared rays, electric-heated plates, and heated drums. The amount of heat added to the frozen food must be strictly controlled and all the heat must be used in the process of changing the water from ice to steam. No heat can be left to raise the food product temperature even the slightest degree until food is completely dry. All during this drying process, moisture extracted from the product must be continually removed from the chamber.

12-21. Two ways to remove vapor from the chamber are with the steam augmentor and ejector system and with the internal refrigerated surface-condensing system. The steam augmentor and ejector system extracts the vapor directly from the cabinet. The internal refrigerated surface-condensing system may be located within the vacuum drying chamber or in a separate chamber. With this system, vapors leaving the drier pass over the condenser, and the water vapor freezes on the outside surface. The vacuum must then be broken so that the product can be removed from the drier.

12-22. The vacuum must be broken in an atmosphere of dry nitrogen because free oxygen absorbed by the dried product will produce oxidative rancidity of the fat in meats. Thus, in unloading, nitrogen permeates the porous tissues and excludes oxygen and water. Packaging the product is still another critical process. The packages must first be flushed with nitrogen or carbon dioxide to remove oxygen. The packaging material must be moistureproof and lightproof and must be protective against abrasion from external forces. Boxes should be packed with desiccants to prevent the absorption of moisture.

12-23. Freeze drying appears to be the ultimate method of maintaining the functional taste and storage stability of certain foods. Foods that may be considered for preservation by this method include various meats, many fruits and vegetables, and numerous seafoods. This method is of great advantage to the Armed Forces because it gives us food products that approximate canned foods in storage stability and surpass them in quality. Freeze drying also reduces transportation costs, since the weight is lessened through the removal of water. However, it seldom reduces space requirements, because freeze-dehydrated foods usually have the same volume as do their fresh or frozen counterparts. An additional freature of this processing method is that because their size is the same, their rehydrated appearance is much closer to that of the original product than is the appearance of canned or other types of processed foods.

12-24. To assist in a nutritional survey of freeze-dried foods, begin by reviewing all contract specifications concerning the food and its packaging and packing, plus any additional documentary material that may have accompanied the test requests. Once you are familiar with the contract requirements, you can then evaluate the adequacy of the packaging and packing materials, the amount of waste during preparation, the flavor, the rehydration characteristics, and the acceptability of the food by the consumer. Rehydration should be performed in a manner suited to the particular food. Normally rehydration of freeze-dried food occurs at a faster rate than it does in those that were dehydrated by other means. This characteristic is made possible by the fact that freeze-dried foods are more porous and their cell structure has suffered less damage or distortion than in other means of dehydration used today.

12-25. When freeze-dried foods are rehydrated they are subject to spoilage by bacteria, molds, yeasts, and enzymes. This is true even if rehydration occurs accidentally. Thus freeze-dried foods, as well as other types of dried foods, must be protected from moisture and other causes of spoilage.

12-26. *Packaging, protection, and storage.* During processing, fruits, vegetables, and meats are enclosed in suitable containers to prevent damage, contamination, and spoilage. Since dried foods are hygroscopic (water-absorbing), these containers must be waterproof. Containers should also be lightproof if the foodstuff has vitamins that are destroyed by sunlight. Dried food packages must also be impervious to gas (oxygen). Packages are made of various types of plastics, aluminum-plastic laminates, wax paper, and cellophane-plastic laminates. These packages are protected from damage by various types of outer containers, discussed later in this chapter. Further protection is provided for these packages by storing them in areas where they are safeguarded from moisture, insects, rodents, other vermin, birds, excessive light, and excessive heat. However, dried foods do not require refrigeration for preservation, as do most foods.

12-27. **Refrigeration.** Food is often preserved by refrigeration, with a resulting reduction in the activity of bacteria, yeasts, molds, enzymes, and chemical reactions. The oxidation and hydrolysis of food and the evaporation of its water content all occur slowly at cool temperatures. Bacteria, yeasts, and molds grow slowly at 32° F. However, enzymatic activity and chemical reactions do not stop until the temperature drops to -40° F. or lower. We see, then, that refrigeration of food offers several advantages. Let's briefly examine the methods of refrigeration.

12-28. Ice is used to refrigerate rail cars and to cool vegetables, poultry, and seafoods. Salt combined with ice lowers the melting temperature of the ice and thus increases its cooling capability.

12-29. Dry ice is solid carbon dioxide and has a temperature of -110° F. It gradually passes from a solid state into a gaseous state without becoming liquid. It is used in ice cream and frozen food trucks and may also be used to preserve perishable foods if the compressor or motor of a refrigerator should fail. If a large amount of dry ice is used in a chill or freezer room, leave the door open for a while before you enter the room; otherwise, you may be overcome by a shortage of oxygen because oxygen can be partially excluded by a high concentration of carbon dioxide gas. Remember this precaution because it could save your life or the life of another.

12-30. You are likely more familiar with mechanical refrigeration than with other types. Except for size, mechanical refrigerators are like the family refrigerator back home and include such working parts as motors, compressors, and coils. Mechanical refrigerators are used to keep foods chilled and to insure that frozen foods stay frozen.

12-31. **Freezing.** Included in the procedural steps (unit operations) for freezing are washing, trimming, dividing, and packaging. These steps have already been discussed in a general way; however, we shall examine some of the special considerations for packaging frozen foods and the procedures for freezing the food.

12-32. To prevent freezer burn, the packages for frozen foods should be gas-impervious and should have no air pockets. Freezer burns on meat are brown spots caused by the denaturization of the protein. These burns result when the cold dry air of the freezer dehydrates the meat and deposits its moisture on the coils of the refrigerator. Such burns can also result from air pockets in the packages adjacent to and around the meat, allowing loss of moisture in the form of condensation deposited on the inside of the wrapper.

12-33. *Procedures.* Commercially, food may be frozen by either blast tunnels or plate freezers. Blast tunnels use high-velocity fans to circulate frigid air for fast and uniform freezing of the food. In plate freezers, each package of food touches plates that are in contact with cooling coils.

12-34. Foods are frozen by either the sharp (slow) or the quick method. In the slow process, from 3 to 72 hours is required to lower the food to -20° F. This slow method has some disadvantages. One is that, as freezing progresses, water is withdrawn from within the cells and forms relatively large ice crystals between them. Upon thawing, these large crystals melt and the resulting water seeps out of the product more rapidly than it can be reabsorbed by the individual cells. Some of the large crystals that form inside cells rupture the cells and allow their liquid content to escape. This leaching or "drip" removes some of the nutrients and lowers the nutritional value of the product. Also, there is excessive fluid loss during thawing and the food will be drier than it otherwise would have been. Another disadvantage of the slow process is that it affects the cells walls that are unbroken. Loss of intecellular water may cause minerals to become so concentrated within the cells that they will not freeze; also, bacterial growth may occur in the food during the freezing process, because it takes several hours for the internal temperature of the food to drop to 15° F. You see, then, that the slow-freeze method has many weaknesses.

12-35. These weaknesses are avoided with the quick-freeze method, which freezes food in 90 minutes or less. In foods frozen by this method, the ice crystals are small, so the cell walls of the food are not ruptured. Furthermore, the internal temperature drops below 15° F. so quickly that bacteria have little time to grow. After this processing, however, and while the food is in cold storage, some deterioration of the food does occur.

12-36. *Deterioration of frozen foods.* Frozen foods may deteriorate as a consequence of too high storage temperatures, fluctuating temperatures, improper humidity, microorganism growth, enzyme activity, chemical reactions, or a combination of any or all of these. We will briefly discuss each of these spoilage factors.

12-37. If frozen foods are to be stored for their maximum stored life, the storage temperature must be optimally low and constant. Temperature fluctuation causes conditions very similar to those that occur during slow freezing, since it produces large ice crystals and the attendant nutritional deterioration. Depending upon their extent, the fluctuations may also accelerate enzymatic and chemical reactions. In the case of variations in relative humidity, when humidity is too low, insufficient moisture dries the stored food. In freezers, the effects of humidity changes are difficult to control by any means other than suitable packaging. When the humidity is below optimum, freezer burn results if the packaging is not intact. While freezer burn is a harmless condition, it is esthetically unacceptable and is irreversible.

12-38. At temperatures above 15° F., molds and other organisms may grow rapidly enough to spoil food, but at temperatures below 15° F., most bacteria, yeasts, and molds stop growing. Some bacteria may grow at 0° F., but not enough to cause spoilage. Even though freezing can slightly decrease the number of vegetative organisms, their number can increase again when the food is thawed if it is not stored under conditions suitable for any fresh product.

12-39. Freezing stops the action of most enzymes but does not destroy them. When food is restored to normal temperature, the enzymes resume their activity. Enzymatic action may lower the vitamin content and food value and change the texture, appearance, and flavor of food.

12-40. Chemical reactions are also reduced as food temperature is lowered. Such reactions include color changes, fat oxidation (rancidity), vitamin destruction (by oxidation or other reactions), flavor changes, and many others. Remember that chemical reactions do continue in frozen foods but at a slower rate. This is the reason that even those frozen foods stored under optimum conditions do not retain their quality indefinitely, but, instead, slowly deteriorate to the point where they are unacceptable to the consumer. Both excessive dehydration and freezer burn can accelerate oxidation, since the removal of water from the surface tissue permits oxygen penetration to a greater depth within the food. Hence there may be very pungent areas of rancid fat immediately under the freezer-burn area. Again the best prevention is optimally low and constant frozen food storage temperatures.

12-41. Regardless of the storage temperature, freezing cannot reverse damage already done to foods. Food keeps its own history—a cumulative record of damage done to it. In storate, the damage continues at a greater or lesser rate, depending upon the storage temperature. As shown in the chart below, the lower the temperature, the longer it takes for a food to develop a slight lessening of quality. (NOTE: The chart is a typical example only and cannot apply to all foods, since many of them will retain quality longer than 2 to 3 days, even though stored above 20° F.)

Storage Temperature	Time Required for Slight Lessening of Quality (Off-Flavor)
0° F.	1 year
5° F.	5 months
10° F.	6 weeks
15° F.	3 weeks
20° F.	1 week
Above 20° F.	2 to 3 days

12-42. Before leaving the storage of frozen foods, let's point out several additional important facts.

a. The longer the storage, the larger the ice crystal, so remember FIFO (first in, first out) for all frozen items.

b. The greater the temperature fluctuation, the larger the crystals, so make certain that freezer doors are kept open no longer than absolutely necessary.

c. Freezing food will not reverse damage already done, so don't try to freeze partially spoiled food to rejuvenate it.

d. No microorganisms will grow in ice crystals, but they will grow in the unfrozen fat of some frozen meats.

e. Any microorganisms that grow in foods while they are frozen are not pathogenic; they make the food taste bad, but they are not injurious to health.

f. In the freezer, nutrient loss is progressive and sure—beef and nonfatty fish are good for 6 to 7 months, and fatty fish are good for 5 months (under ideal storage conditions).

g. Don't load an open-top (display-type) freezer unit above the load line arrow. The top layer may thaw.

12-43. *Defrosting.* As we have already pointed out, foods should be frozen rapidly so that the ice crystals are small, cell walls remain unbroken, and the cells retain most of their moisture. But what about thawing? Frozen beef and pork should be thawed slowly in the refrigerator so that the cells have time to reabsorb any moisture they have lost during freezing. Fish should be thawed rapidly, preferably by cooking, since slow thawing may denature fish protein. Thawing by cooking is a must for frozen vegetables and certain fruits. Some meat, too, may be cooked from the frozen state provided it is started directly from the frozen state.

12-44. Now consider accidental thawing and what you can do about it. On occasion, frozen foods may thaw while in transit. In other instances, thawing results from electrical power failure or from the mechanical failure of a freezer. In either event, if failure is likely to be prolonged, dry ice (if available) should be used to keep the foods frozen. If frozen foods begin to thaw in spite of precautions, what should be done with them? Should they be refrozen? No! The Air Force has freezers to maintain previously frozen foods but does not have blast freeze facilities to quickly refreeze foods.

Thawed foods would have to be refrozen slowly and would have time to deteriorate and to develop off-odors.

12-45. What, then, should be done with thawed foods? The answer to this question depends upon the internal temperature of the foods, the length of time they have been at this temperature, and the type of foods. With nondangerous items such as plain fruits and vegetables, or highly acid items like sauerkraut, the length of time outside proper storage temperatures is not as critical as it would be for more dangerous food items. In this respect, such foods as creamed meats and some creamed vegetables are very dangerous and have narrow margins of safety. If the internal temperature has gone much over 40° F. for over 4 hours, condemn the food.

12-46. When you know that the particular food is one that would not spoil in the period of exposure to improper temperature, the food should be force-issued and used within 24 hours as a chilled-food item. If the food is still solidly frozen but its internal temperature ranges upwards to 20° F., it should be placed in another freezer and the temperature taken back to 0° F. or to whatever is optimum in your warehouse. The food should be identified by suitable markings so that it can be issued ahead of similar products that have not been distressed by being partially thawed by fluctuating temperatures.

12-47. Forced issues can be authorized only by the Base Commander upon the recommendation of the Veterinary Officer or his representative. Such actions should, of course, be coordinated with the Commissary Officer and/or the Food Service Officer. This will insure that the product is used within the time limit you specified.

12-48. **Canning.** Canned goods are the safest of all preserved foods. Some advantages of canning are:

a. Seasonal food surpluses can be preserved for year-round consumption.

b. Foods can be preserved and used anywhere in the world.

c. The canned products are available for consumption with a minimum of preparation.

d. The wastes are removed before canning.

e. Minimum storage space is required.

12-49. Some specific military advantages of canned foods are that individual rations have been developed for use in the field and that the sealed can protects foods from nuclear, chemical, and biological contamination.

12-50. Foods to be canned must be harvested and prepared under close supervision. Included in the processing steps are cleaning, dividing, blanching, filling cans, preheating, heat processing, and cooling. Cleaning, dividing, and blanching have already been discussed in this chapter. The cans are filled either by hand or by machine. Preheating, before the cans are sealed, is done either by using already heated food or by passing the unsealed can of food through a hot water bath or steam tunnel. Preheating drives off gases to give a solidly packed can and helps to blanch the food. After the can is sealed, heat processing, or restoring as it is called, is done by placing the sealed can in pressure cookers and exposing the canned foods to various combinations of temperatures and time. The temperature and time to use depend largely upon the pH of the food product involved. The usual restoring time and temperature is 3 minutes at approximately 250° F. if the food is not very acid. For fairly acid foods, this time and/or temperature may be reduced. Highly acid foods may not be subjected to any heat processing. Heat processing not only destroys undesirable microorganisms but also cooks the food to some degree and stops enzymatic action. The time and temperature of 250° F. for 3 minutes used in processing nonacid foods is based upon the fact that this is the minimum combination capable of killing the bacteria that cause botulism.

12-51. Following the heat treatment, the cans are flooded with cold water to cool them quickly. This stops the cooking and drops the temperature of the can to about 95° F. Even though 95° F. is warm enough to help dry the cans, this temperature is too low to allow the growth of thermophiles, which grow rapidly between 115° F. and 125° F. When canned foods have been adequately processed, they are called "commercially sterile." This term means only that under normal conditions there will be no microorganism growth within the sealed can. "Commerically sterile" does not mean that all microorganisms have been killed, as would be the case with surgical sterility from an autoclave.

12-52. Another form of heat processing now in general use is called "aspetic canning." In this process, the food is flash sterilized by being exposed to surfaces superheated by steam to temperatures close to 400° F. At the same time the food is being flash sterilized, the cans and lids are also being flash sterilized with superheated steam. The food does not leave the sterile chamber but is put into the sterile cans while still in the sterilizing chamber and the can is sealed under these aseptic conditions. The result is a basically sterile product that has extremely long keeping qualities. This process is currently being used primarily to prepare sterilized milk and other dairy products, such as ice cream mixes.

12-53. **Packaging.** Canned food containers are glass bottles or metal cans made of tinned steel or of aluminum. The use of glass is generally limited to foods that are not highly perishable. The advantages of glass are that it is cheaper and the consumer can see the contents. Its disadvantages are that it breaks easily and that food in it cannot be processed under high temperatures and pressures. Cans do not have these disadvantages.

12-54. Cans are manufactured from steel base plate to which a thin film of pure tin has been coated electrolytically. Various types of enamels may be used to protect the interior surface of some cans. However, many canned food items are placed in cans with no enamel coating. Enamels are used to inhibit undesirable reactions between the metal and the product. Such reactions may produce hydrogen swells (hydrogen gas released inside the can) and discoloration of the product. To be suitable for use inside cans, the enamels must be nontoxic, must not react with food, must withstand fabrication without chipping or flaking, and must adhere firmly to the tin plate.

12-55. Two types of enamel frequently used in cans are "R enamel" and "C enamel." R enamel is used for pigmented fruits and vegetables to preserve their natural color. C enamel, which contains 15 percent finely powered zinc oxide, is used for canned corn, meat, fish, and poultry products. Without this enamel, the sulfides released in protein breakdown react with iron and tin to form black tin and iron sulfides. With the coating of zinc, the sulfides react with the zinc to form white zinc compounds that are not objectionable in appearance.

12-56. Before leaving our discussion of cans, let's briefly consider the external coatings applied to some cans to prevent corrosion and to provide camouflage. There are three types of these coatings. Type I is a precoated camouflage paint that is applied before the fabrication of the can. The side seams of the can must be painted after retorting (after the can has been sealed and its contents cooked). Type II is a postcoated camouflage that is applied after retorting. It may be applied by brushing, dipping, or spraying. Type III is precoated and unpigmented. Known as "gold enamel," it may be applied before or after restoring.

12-57. You see, then, that cans have been carefully designed to protect food. Their excellent design combined with the superb, modern processing techniques now used in canning, has practically eliminated the threat of food poisoning from commercially canned products in this country.

12-58. **Radiation.** Preservation of foods by radiation is limited to the use of electrons and gamma rays. Gamma rays and electron radiation can be used to kill microorganisms and insects in food. Electron radiation derived from electrolinear actuators and gamma rays derived from cobalt 60 or cesium 137 have been used to keep potatoes from sprouting, to kill insects in grains, to delay the ripening of fruits, to speed the ripening of fruits, to kill salmonellae in eggs, to kill trichinae in pork, and to preserve bacon and various other kinds of foods. A medium level of radiation (100,000 to 1,000,000 rads) kills nearly all the microorganisms, but the product is not rendered completely sterile. Perishable foods treated in this way have a longer shelf life when they are stored under refrigeration. Exposures of 1,000,000 rads cause certain foods to lose quality. Large doses of radiation (up to several million rads) have been used to sterilize some foods but may cause softening of vegetables and off-flavors in meats and fats. Recent findings indicate that if foods are irradiated at low temperatures, the production of such off-flavors is reduced. Furthermore, findings show that the use of gamma rays or electrons do not produce radioactivity in foods.

12-59. **Fermentation.** During fermentation, the acid formed lowers the pH of the food and helps to preserve it. For example, the natural sugar of a food may be changed by microorganisms (bacteria or yeasts) to lactic acid, then to alcohol, and finally to acetic acid. Either lactic or acetic acid will act as a preservative by lowering the pH of various foods. In the majority of those foods preserved by fermentation, the process is accomplished by the formation of lactic acid rather than by acetic acid. For example, cheese, sauerkraut, olives, etc., are all preserved by lactic acid. The pH resulting from fermenting foods is adequate to prevent the growth of all pathogens. It will not prevent the growth of a few types of spoilage microorganisms, nor will it effectively stop enzymatic activity. Hence, many fermented foods, such as sauerkraut, must be pasteurized and canned or bottle, if indeed they are not actually heat processed. Here, let's discuss sauerkraut and cheese as examples of processing by fermentation.

12-60. *Sauerkraut production.* Sauerkraut is produced from cabbage. The cabbage is washed and shredded and salt is added to a concentration of 2.25 percent to 2.5 percent. The shredded kraut is packed in vats and weight is applied to submerge it in the brine solution. The temperature is held at 70° F. to 75° F. during lactic acid fermentation. When the right amount of acidity is produced, either heat or cold is used to stop the fermentation. Most sauerkraut for the Armed Forces is canned and subjected to heat treatment during canning.

12-61. *Cheese.* The principal function of bacteria in cheese making is to produce acid. The action of the bacteria helps to curdle milk, expel whey, gather the curd, and protect against putrefaction. Bacteria and molds are responsible for the different flavors of cheese.

12-62. **Curing.** Curing is a method of preserving or imparting a particular flavor to various meat products. Salt is the basic curing agent, but it may be supplemented with other agents, such as sodium nitrate, sugar, spices, and many other supplementary products. The primary objective in curing meat is to prolong its keeping quality. This is done by saturating the tissues with salt, which eventually destroys most of the microorganisms.

The salt does not destroy all pathogens; the curing process will not make trichinae-infested pork safe.

12-63. Meat was originally cured in order to preserve it. The need to cure meat for this purpose is not as great today as it originally was, because refrigeration is available now. Consumers have the same eating habits they had before refrigeration was developed, and they still demand the flavors and colors of cured meats.

12-64. *Salt.* Salt used in the curing formula may be used alone or with other ingredients. Salt is basically a preservative, it extracts moisture from meat, and imparts flavor. Salt also tenderizes foods, especially the skin of vegetables. Salt in a 15-percent solution will preserve foods, control enzymes, help remove water, and prevent the preserved food from absorbing metal from the can. When used on meats, however, salt destroys their color. This is why nitrates and nitrites must be added if a pink or red cast is desirable.

12-65. *Sugar.* The preserving characteristics of sugar are similar to those of salt, though sugar does not have these characteristics to the extent that salt does. Sugar adds flavor, removes some moisture, tones down the brackishness of salt, and furnishes food for growth of the bacteria desirable in the curing process. Excessive amounts of sugar do not enhance the keeping quality of meat, but they may cause it to turn dark red. Sugar is also used with sodium nitrate in the curing of meat. There, the sugar feeds bacteria that are essential to reduce sodium nitrate to sodium nitrite.

12-66. *Nitrates.* Sodium nitrate and potassium nitrate act as reservoirs for nitrites, thus maintaining an effective level of nitrite for the curing of meat products.

12-67. *Nitrites.* Nitrites are produced from the action of reducing bacteria on sodium or potassium nitrate. Nitrites unite with hemoglobin or myoglobin to form nitric oxide myoglobin, which, in the presence of heat, yields nitric oxide myochromogen (a stable color). Nitrite salts may be added to the nitrates to insure that there is enough nitrite for color fixation. The quality of the nitrites added is carefully controlled by APHIS to avoid creating toxic effects.

12-68. *Pickle.* The term "pickle," as applied to meat curing, means a solution of the curing agents. A plain pickle is simply a solution of salt in water. A compound pickle contains salt, sugar, and/or sodium nitrate and/or sodium nitrite. A pickle that contains sugar in some form is also known as sweet pickle.

12-69. *Smoke.* Egyptians and ancient Sumerian civilizations smoked meat. In North and South America, the Indians smoked meat over the tops of their tepees. The smoking had some drying and preservative effect from the heat and the release of pyroligenous acid in wood smoke. Today, meat is smoked mainly to give it flavor and color. The preservation is done by the curing process.

12-70. The objectives of smoking meat are to retard bacterial growth by the removal of moisture, to impart a desirable smoked flavor, to stabilize a cured color, to prevent oxidative rancidity, and to kill surface bacteria.

12-71. **Use of Food Additives.** In addition to the use of salt and sugar discussed in curing meats, we use many other additives, some of which are discussed in this text. For centuries man has used additives to preserve food. A good example is salt (sodium chloride), which has been used since ancient times. Today, through advances in chemistry and food technology, many chemical compounds are added to foods to stop the growth of microorganisms without injuring the foods. The use of chemical preservatives in food is closely controlled by the Food and Drug Administration, which has enforcement responsibility for the Federal Food, Drug, and Cosmetic Act, the act that regulates foods that enter interstate commerce. Some of the established criteria pertaining to the use of chemical food additives are that they must:

a. Not injure the consumer.
b. Improve the food material.
c. Not reduce action of digestive enzymes.
d. Not react to form harmful compounds in the body.
e. Be easily identified.
f. Be proved safe before use.

12-72. Among the additives used in foods are sugar, acids, salt, antibiotics, sulfur compounds, oxidizing agents, antioxidants, enzymes, and food flavor amplifiers. We will examine these allowed additives and then briefly consider a few forbidden additives.

12-73. *Acids.* Acids are used to improve the flavor of foods and to help in food preservation. Among the acids used in foods are the benzoates, the propionates, citric acid or citrus juices, acetic acid, and phosphoric acid. Acids are added to foods to attain a pH that is unacceptable to those organisms that are present. While to some persons they enhance food flavors, to others they harm the taste. From a practical standpoint this information may be useful to you. When potato salad is acidified to a 4.5 pH level, it is much safer to serve than is the normal, rather bland potato salad or sweet potato salad concoction. This is also the reason that various fruit and lemon-custard-type pies need not be refrigerated. They, too, have a low pH.

12-74. Benzoic acid in a concentration of 0.1 percent is fairly effective in preventing the growth of yeasts. Its bacteriostatic action is enhanced by such products as phenylbutyric acid. Esters of vanillic acid (a derivative of p. hydrobenzoic acid) are effective against many microorganisms, including molds and some heat-resistant, spore-forming bacteria. The use of ethyl vanillate in World War II made it possible to deliver acceptable foods to many parts of the globe.

12-75. The salts of propionic acid (a fatty acid) are nontoxic; they are used to inhibit mold in bread and cakes. Propionates are also used to inhibit the growth of surface mold in cheese. Soft cheeses, such as cottage cheese and cream cheese, may be protected from mold by the addition of 0.15 percent of calcium propionate.

12-76. *Antibiotics*. These are chemical substances produced by certain living cells, such as bacteria, yeasts, and molds. They may prevent disease-producing or spoilage organisms from multiplying, or they may kill them. Two antibiotics, oxytetracycline (or terramycin) and chlortetracycline (or aureomycin), have been approved as antibiotic additives for chicken and whole gutted fish. Their use slightly extends the shelf life for these highly perishable products. It is debatable whether their use is really worthwhile, when weighed against such disadvantages as creating resistance to these antibiotics in certain bacteria. In the canning industry, two antibiotics that show promise in accelerating the speed of killing spores are subtilin and nisin.

12-77. *Sulfur compounds*. Sulfur dioxide and various sulfites are used in the preservation of acid fruits and vegetables. They are effective against molds but are not very effective against yeasts. The sulfur substances can reduce food palatability and may inactivate some vitamins. Fruits are sulfured by burning sulfur or by exposing fruit to sulfur dioxide gas. Apples may be dipped in a solution of sodium bisulfite or sulfur dioxide.

12-78. *Oxidizing agents*. Oxidizing agents are used in meat, fish, flour, fruit, and vegetable preservation. Sodium nitrate and sodium nitrite are used in meat curing. These are broken down to nitric oxide, which is a color fixative. Bleaching agents are used to preserve flour. Other oxidizing agents include hypochlorite solutions to inhibit mold growth on fruits.

12-79. *Antioxidants*. Antioxidants are substances that are added to foods to protect them chemically against oxidation. A common form of oxidation is one type of rancidity of fats. This oxidation (oxidative rancidity) may develop and be accelerated by light air moisture, heat, and catalysts, such as copper. Among the antioxidants used are the tocopherols, cephalin, gum guaiac, propyl gallate, ascorbic acid, and citric acid. The tocopherols (including vitamin E), come from vegetable oils and are good antioxidants for animal fats. Cephalin comes from soybean lecithin, and is a good antioxidant. Gum guaiac is an antioxidant and stabilizer for many fats, including dehydrated fats. Propyl gallate, not to exceed 0.01 percent, preserves lard. Ascorbic acid is used to prevent the rancidity of mayonnaise and to prevent the browning of the unprocessed cut surfaces of such fruit as peaches, apples, and apricots. Two percent citric acid or 0.1 percent hydrocloric acid are also used to prevent sliced peaches from browning.

12-80. *Enzymes*. These substances are used to break down connective tissues and tenderize meat. Tenderizing enzymes include papain, bromelin, ficin, and asclutin, each of which is heat labile.

12-81. *Flavor amplifiers*. Included in the flavor amplifiers are monosodium glutamate and many spices. With a few exceptions, these flavor amplifiers are not food preservatives. Some spices, such as cloves and cinnamon, are bacteriostatic to some degree, and some are even bactericidal in certain situations.

12-82. *Artificial sweeteners and miscellaneous*. Artificial sweeteners are widely used in dietary foods as well as in many other foods consumed with no dietary intent. Artificial sweetners have no food preservation quality as sugar might have. Consequently, foods that might have been preserved had they contained a high sugar content are not preserved solely by the addition of artificial sweeteners. Thousands of other food additives are approved for use under the guidance of the Food and Drug Administration. All have specific criteria for use, and some are toxic if applied beyond the limits intended for their use. Others have special disadvantages in their use. Questions concerning additive usage should be referred to the closest Food and Drug Administration representative.

12-83. *Forbidden food additives*. Among the forbidden food additives is sodium sulfite, a toxic substance sometimes used illegally to redden stale meat. Also included are sodium nicotinate, salicylic acid, hydrogen peroxide, and quaternary ammonia compounds. Except for use on poultry and fish, antiobiotics are also forbidden.

13. Packaging and Packing

13-1. Foods must be packaged (placed in an individual container or can) and then packed (several packages made ready for storage and shipment) in various ways so that wholesome foods can be delivered to military installations all over the world. Your job will necessitate an ability to recognize markings and labeling, and, in some instances, the capability to inspect for proper packaging and packing in terms of the contract. There is a tendency to overemphasize the inspection of food and to underemphasize the inspection of the package or container. In this section we will look, in a broad general sense, into the purpose of packaging, discuss the types of packages, and then take a brief look at the materials used to pack the packaged products.

13-2. **Purpose and Types of Packaging.** Foods for military consumption must be stored in all kinds of climates. The package protects the food and serves as a convenience in using and handling. The package or container must protect the food from moisture, excessive heat and cold, insects, rodents, some pressure from weights in storage, acids, alkalies, oils, and damage caused by rough handling (it is evident that the packing aids many of these protective functions). Yet the container must not impart any odors, tastes, or toxic material that the food can absorb. A perfect package has not been developed, but new developments tend toward increased tensile strength, lighter weight, and increased resistance to vapor, to temperature variations, and to flammability. For convenience to the military services, the weight, strength, and size of the container are important. Consideration must be given to reduction in shipping costs, to shipping problems encountered in moving products from warehouses to using facilities, and to the placement of the products onto shelves and into the refrigeration equipment of dining facilities. Individual containers must be easily opened with standard Air Force dining hall equipment. Packages must be labeled for proper dining hall identification.

13-3. The individual packages easily fall into two general categories—rigid and flexible. Tin cans are still the most prevalent form of container used in packaging, but are being replaced by the aluminum can and by the glass container, which is also classified as a can in a broad sense: "a jar for packing or preserving fruit." Cans may also be classified as to method of filling. An example of the vent-filler can is an evaporated milk can, spot soldered on the end at the spot where the milk is injected. An example of the hole and cap is the Log Cabin Syrup can or the Wesson Oil container. An example of the sanitary can is an ordinary can, for instance, a normal tin can constructed of cold rolled steel coated with tin and soldered at the ends. As has previously been pointed out, cans are enameled to protect the product. Can sizes are usually expressed as two three-digit numbers, the first referring to the diameter and the second to the height. The first digit of a can size reflects the whole number of the size, in inches; the next two digits, the fractional inches in sixteenths. Thus, a can size "401 x 412" is a can whose diameter (first three digits) is 4 and 1/16 inches, and whose height (second three digits) is 4 and 12/16 inches (4¾ inches). In the example "401," note that the zero is used as a filler.

13-4. Flexible packaging materials are numerous. Of interest is the imperviousness (not allowing passage) of the material to light, gas, or water vapor. Let's start with one of the earliest wrappers developed, waxed paper. If it is waxed on only one side, it is considered impervious only to water vapor. Aluminum foil is impervious to vapor, gas, and light but is not considered good as a commercial wrapper unless laminated to other materials because it loses imperviousness when wrinked (it cracks). Cellophane is not tough and is water pervious. It is oxygen and gas impervious until wet. Since meats must be packed so that oxygen can get in and permit breathing, cellophane is often used because the meat juices wet the cellophane enough to permit the passage of oxygen. Cellophane is often laminated to other wrapping materials. Saran is a wrapping material impervious to everything. Polyethylene is tough and water impervious, but it is pervious to gases and is shrinkable. On the other hand, polyvinyl chloride is pervious to oxygen, is strong, is water impervious, and does not shrink. Mylar (scotch-pack) is a wrapping used when foods are to be cooked in the package. It is the strongest, most resistant of the flexible packaging materials, is a chemical repellent, and is water and gas impervious. Amino acids can be synthesized into any meat or container, creating an interesting flexible packaging material, a synthetic protein film. When it is used to wrap foods (such as sausages), the consumer actually eats the package!

13-5. **Purpose of Packing and Packing Materials.** Packing is the grouping of a number of small packages or units into one larger unit or pack, using such materials as are necessary to protect against mechanical damage, loss, pilferage, dirt, contamination, moisture, and other conditions that may affect the wholesomeness or storage life of foods.

13-6. The packing materials used are paper, cloth, wood, metals, and synthetics, such as fiberboard. Packs include boxes, crates, bales, bundles, sacks, bags, drums (metal or fiber), fiber cans, wooden barrels and kegs, miscellaneous packs, and palletized unit loads.

13-7. Marking for shipment and storage is in accordance with applicable military standards but, in general, for perishable subsistence, it conveys this information:

a. Item description and grade (or brand).
b. Quantity, size, unit, and total net weight.
c. Gross weight and cube.
d. Date packed (month, day, year).
e. Contract or purchase order number; name and address of contractor.
f. Special markings.

The standard markings for perishable subsistence do not apply to fresh fruits and vegetables. These markings are made as specified in the contract or purchase order.

14. Cold Storage Practices

14-1. More than half of the military ration consists of perishable items that require refrigeration. You will inspect the following foods in a cold storage environment: fresh and frozen meats and meat products; fresh and frozen fish and other waterfood products; poultry, eggs, and dairy products; fresh fruits and vegetables; and other frozen foods. To reflect job practices, we will briefly review the functional parts of a cold storage plant and will discuss general storage practices that are essential for well-informed inspectors to know.

14-2. **Parts of a Cold Storage Plant.** Let's visit a typical cold storage plant and look at the freezer storage room, the meat chill room, the cooler rooms, and the ventilated storage room.

14-3. *Freezer storage room.* Ideally you will find the freezer storage room maintained at a temperature of 0° F. to -10° F. with a minimum of temperature fluctuation. All food items that are frozen when received are stored here. Especially watch for subsistence items that deteriorate in prolonged storage (such as pork, sausage, frankfurters, salami, precooked frozen in-flight meals, TV dinners, and meat pies). These items must be stored at temperatures no higher than -10° F. if at all possible. If you notice food products stacked with stripping (pieces of thin boards) between tiers, it may indicate that the food product was received at 20° F. or above and was, therefore, specially stacked to insure a circulation of cold air around the containers. Stacking will be further discussed later. Other foods received at below 20° F. are normally piled into compact stacks without stripping between tiers.

14-4. If you find the contents of a container removed and scattered, it probably indicates that a product was received partially defrosted. It was scattered so that it would refreeze quickly, as any accepted partially defrosted item must be refrozen without delay. You may find a fan being used to circulate the cold air rapidly in such cases. If not, recommend such practices if they are necessary. You should also make sure that these refrozen foods are always marked in some way so that the refrozen lot can be issued before other products in the same category are used, since those that were refrozen have a markedly shortened shelf life. Good inspectors insist that frozen beef carcasses be hung if at all possible. Under no normal circumstances do wholesome practices permit foods to be frozen in the freezer room, since freezing takes place too slowly and results in a product of inferior quality.

14-5. *Meat chill room.* As we continue our inspection tour, we enter the meat chill room (or rooms). Notice that the temperature is maintained at 30° F. to 32° F. Suppose that an error has been made, and the temperature held below 30° F. Slow freezing of the product would result, and you could expect to find discoloration and loss of quality in the product; but this is a rare occurrence. Normally, you can expect to find the following items stored in the meat chill room: fresh meats and meat products, fresh poultry, and smoked or salted ham and bacon. Fresh pork and pork sausage need a lower storage temperature. If, as is often the case, this is the only meat chill room available, the pork should be stored in the coldest part of the room for no longer than 48 hours, and a good inspector will be alert to guard against other practices endangering the wholesomeness of the product.

14-6. *Cooler rooms.* On an inspection tour you will normally find at least two cooler rooms. Dairy products, eggs, lard, and lard substitutes are stored in one room; while, to prevent the transfer of taste and odors, fresh fruits and vegetables are stored in another room. (This excepts those less perishable items stored in the ventilated storage room.) You should find both cooler rooms maintained at 35° F., and again the temperature should not be allowed to fluctuate. Careful control of the velocity of the refrigerated air is necessary. Dehydration and damage to the stored food are points to look for on inspection and could indicate excessive air velocity. If your base does not have a ventilated storage room, or if it is not using it to store such items as cucumbers, eggplant, tomatoes, etc., make sure that the fruit and vegetable cooler room mentioned below is not held below 40° F. Temperatures below 40° F. can damage some fresh vegetables.

14-7. *Ventilated storage room.* You will usually find the less perishable fruits and vegetables, such as potatoes and apples, stored in a well-ventilated storage room. Sometimes refrigeration is available, although in cold climates it is at times necessary to heat the room to prevent the temperature from dropping below 38° F. The room is preferably maintained at 40° F. If white potatoes are stored at a temperature below 40° F., they will develop a sweet taste, so keep this in mind while inspecting. Common foods that you may find stored in ventilated storage are apples, avocados, beets, citrus fruits, cucumbers, eggplant, dried fruits, honey, canned meats, honeydew melons, onions, parsnips, pears, peppers, potatoes, pumpkins, squash, tomatoes, turnips without tops, and canned evaporated milk. The following points are of interest to you as an inspector: food is stored here only to lengthen its shelf life; temperature control is involved as well as ventilation (honey, canned goods, etc.); pinpointing caused by condensation forming on cans may denote inadequate ventilation; and honey turning to sugar denotes improper (too low) storage temperatures. Space availability is a factor in placing a product in the ventilated storage room.

14-8. **Factors Affecting Cold Storage.** What factors that accelerate spoilage can you help control in your inspection? They are:

a. Lack of heat withdrawal from the product shown when packages are not adequately spaced.

b. Rough handling (not much you can do).

c. Incorrect humidity (some items need more than others—if the situation cannot be controlled, recommend that these items be issued at an earlier time).

d. Mildew resulting from too much humidity (recommend that the door be kept closed as much as possible and if mildew is still a problem, scrub the walls with detergent and water, followed by a plain water flushing—then by a flushing with quaternary ammonium compound or, if it is not available, with clorox solution).

e. Lack of ventilation (control the height of the stacks off the floor and the distance from the walls, and use stripping).

f. Crushing (recommend that bags not be stacked more than four or five high).

g. Ensure stock rotation (this is probably the most important existing warehousing provision; FIFO—first in, first out—should be everyone's byword).

h. Fluctuating temperatures (examine the temperature records).

i. Defrost units (determine if defrosting was adequate).

14-9. **General Storage Practices.** There are general practices and terms concerning stacking, dunnage, and ventilation. Stacking is the placement of packaged items and carcass meat in neat, compact stacks, with a space of 4 to 6 inches between the food and the wall, and 18 inches between the top of the stack and the ceiling. Floor dunnage (2 x 2-inch strips of word or metal) is frequently used to keep food products from touching the floor and to allow air circulation beneath them. The amount of ventilation necessary depends upon the commodity stored. For instance, fresh fruits and vegetables require ventilation in the stack, although cases or boxes can usually be stacked so that there are ample air spaces in the stacks. Shell eggs in wooden cases need not be stacked with wooden stripping if they are stored only a few days, but if they are in fiberboard cartons or are to be stored longer than a few days, the tiers must be separated with wood stripping. Tiers of boxes or cartons containing fresh meat products must be separated with stripping of thin boards or laths.

14-10. Frozen meats, meat products, poultry, fruits, and vegetables, received at temperatures below 20° F. and solidly frozen, are correctly stored for stack ventilation if the dunnage on the floor is at least 2 inches thick and the product is stored 4 to 6 inches from the wall. As it was indicated earlier, items received at temperatures higher than 20° F. are correctly stacked with stripping.

15. Dry Storage Practices

15-1. Nonperishable subsistence can generally be defined as foods that can be stored without refrigeration and includes canned goods, sugar, flour, condiments, cereals, preserves, salt, and dehydrated foods. The guide for dry storage warehousing layout is in AFM 145-1, *Commissary and Subsistence Depot Operating Manual.* The Veterinary Service inspects storage facilities for sanitation and adequacy for the preservation of all subsistence. Points to check when you are inspecting nonperishable storage facilities are the use of pallets, heating facilities, ventilation, security, insect and rodent control, storage charts, markings, and epidemic spoilage. We will discuss each of these items and some other general dry storage practices.

15-2. **Use of Pallets.** Pallets are usually 40 x 48 inches in size. Cargo pallets which may be used to store heavy materials may be 48 x 72 inches. Pallets are designed so that forklifts can move them with their contents and must be sturdy enough to withstand the weight of the foods stored. You must also inspect another type of pallet, the box pallet, which has a standard pallet base with a vertical and top framework. This pallet is designed to store odd-sized and odd-shaped containers, or containers that are easily crushed, so observe them for evidence of crushing. You need to check the air space under the foods for adequate cleanliness and to see that provision has been made to implement effective rodent control. There should be enough space for placing rodenticides but not enough so that rodents can find harborage.

15-3. **Heating and Ventilation Facilities.** Most dry storage warehouses must be heated during cold seasons. An inspector must be observant because glass containers and liquid canned goods are particularly vulnerable to freezing. Some dry canned goods containers can withstand freezing. Freezing, however, can cause undesirable changes in appearance in the food, and can cause cans to burst. On the other hand, in warm weather, storage buildings must be adequately ventilated. This may be done with vents and windows; if necessary, exhaust fans may be used.

15-4. **Security.** All dry storage facilities should be locked when the building custodian is absent. Loading and unloading doors should have an overhead light for use during hours of darkness. Sensitive food items are usually stored in a room that is kept locked. Outside windows are covered with chain link security fence or iron bars. As a precautionary measure, you should have the commissary building custodian's permission to enter a building to perform your inspections. He or one of his men should accompany you all the time you are in the building.

15-5. **Insect and Rodent Control.** The first step in insect and rodent control is to insure that no subsistence is infested with rodents, weevils, or other vermin. Such products as flour, dry beans, rice, raisins, macaroni, spaghetti, noodels, and cereals are particularly vulnerable to insect infestation. When performing an inspection, you should check the housekeeping procedures, the rodent-proofing, the frequency of stock rotation, and evidence of insects and rodents. If insects and rodents are found, you should report this, along with your written recommendations about their control, to the Commissary Officer.

15-6. **Storage Charts and Markings.** Charts showing the storage life of nonperishable subsistence are found in AFM 145-1, *Commissary and Subsistence Depot Operating Manual.* Food containers without a packing date should be stamped to show the date that they were received. This tells you how long the product has been in the warehouse and is a means of controlling proper stock rotation.

15-7. **Epidemic Spoilage.** This is spoilage that occurs when a can (or cans) in a stack of cases ruptures and the contents leak on cases and cans that are stored below. The leakage spreads laterally and downward in a bell shape. Whenever epidemic spoilage is detected in a stack of subsistence cases, the spoiled cases and cans must be removed immediately so that further spoilage does not occur. The spoiled contents of the ruptured cans will spoil other cans when they spill on them.

15-8. **General Dry Storage Points.** Here are some general dry storage points that you as a food inspector need to consider:

a. Again, proper stock level control, along with FIFO (first-in, first-out), are mandatory practices. They must be conscientiously checked by inspectors and followed by warehouse personnel.

b. Don't stack too high.

c. Insects and rodents ruin the wholesomeness of dry foods in storage.

d. Check for ruptured cans and pyramids.

e. Check for mold.

f. Stack 6 to 8 inches away from wall.

g. Don't stack closer to the ceiling than 18 inches.

h. Keep food stacks off the floor.

i. Avoid stacking in front of windows or any other source of heat.

j. Close doors on wet days; open them in dry, sunshiny weather.

k. Write to the company and secure its codes to interpret the pack date of its standard brands.

l. Destructive sampling is at commissary expense.

16. Inspection of Canned Goods

16-1. Since you do not usually perform "Prior to Purchase" Class 3 Inspections (of canned goods) you will not often follow a definite inspection plan as is specified in an individual contract. However, if you are performing a destination inspection (Class 4), inspect a representative number of units on a statistical sampling basis. If more defects or defective units are found than are allowed, notify DPSC (Defense Personnel Support Center). When inspecting canned goods on a Class 5 inspection, remember that the invoices on these Government-owned products normally designate a condition code for the product. Three codes are used—A, B, and C. Code A means prime quality; Code B means intermediate quality; and Code C means the product should be issued as soon as received and not held for any extended period of time. The "during storage" inspection (Class 9) is limited to ensuring that the product is sound. We will discuss the problem from the angle of your examination of the individual can or the primary container, and, as necessary, of its contents. To do this, we will break the examination into two phases: spoilage when cans appear normal and spoilage when cans appear damaged because of a major or a minor defect.

16-2. **Cans Appear Normal.** In any open-can inspection, usually used in conjunction with statistical sampling (covered elsewhere in this course), you may discover the following defects:

a. Soured contents (flat souring, usually caused by thermophiles; contents develop excess acid without the formation of gas).

b. Black contents (caused by the reaction of sulfur and steel, or of steel with sulfur-producing bacteria).

c. Spangling (tin reacts with the food components, appears as little dark blotches on inside of cans, does not aversely affect food, often seen in cans of tomatoes).

d. Texture, color, or taste of food is "off," (evaporated milk must be rotated and periodically inverted to prevent settling and appearing grainy).

e. Pinholes (small and at first invisible) mean that the contents of the can are contaminated from the outside. Gas, but not necessarily liquids, escapes through pinholes. Since pinholes usually occur around the groove of the seam, running the point of a ballpoint pen along this juncture will often puncture them or allow you to feel a defective area.

16-3. **Defective Cans.** A visual examination of a primary container includes its type, style, size, condition, exterior coating, and labeling. Dents in cans are described by such terms as "body dents," "end seam dents," "buckled seams," and "paneling" (caused by excessive vacuum). You must especially consider major and minor defects. A major defect is one that can result in failure or materially reduce the usability of the unit. A minor defect does not materially reduce the usability of the unit; it either limits its serviceability or is a departure from the established standard—a departure that has no bearing on the effective use of the unit.

16-4. When you perform a during-storage inspection, the primary consideration is the condition of the product. If you are performing an acceptance inspection, the percent of major and minor defects becomes an important and controlling factor. The AMS Handbook, *Exterior Condition of Filled Food Containers,* U.S. Department of Agriculture, Agriculture Maketing Service, pictures both the upper and lower limits of major and minor can defects. For instance, any severe body dent (deep and sharp dents with sharp angles to the points) is classified as a major can defect; so is a severe body dent involving an end seam with possible disruption of the hermetic seal. A moderate body dent involving an end seam is classified as a minor defect. Your supervisor can help you acquire skill in further identification of body dents in cans.

16-5. **Distended Cans.** There are other defects that relate to distended cans, all of which are normally classified as major. The descriptive terms "flipper," "springer," and "sweller" are used rather loosely by the canning trade. A "flipper" is a can that has too little vacuum. The can appears normal until struck on a flat surface. The blow causes the opposite end to distend until forced back into position. The causes of this condition are overfilling, insufficient exhaustion, or either chemical or bacterial action. "Springers" and "swellers" are more easily located and are predominantly caused by gas formation. A springer is a can with one end distended. If the distended end is forced in, the other end will distend. A sweller can has both ends distended. Varying degrees of internal pressure are denoted by such descriptive terms of visible-can defects as "soft swell," "hard swell," "bucked," "buckled," and "peaked." You must determine the wholesomeness of the canned products where any of the above defects are found. You must act according to regulations as to the use or disposition of the affected cans. Some amplifications that better explain the causes of swelling are as follows:

a. Hydrogen swells are caused by a reaction between acid foods and the metal can, releasing hydrogen gas.

b. Carbon dioxide swells are usually produced by microorganisms growing in the canned food. Ordinarily they are nonpathogenic; but, occasionally, as in the case of botulism, they may be pathogenic.

c. Carbon dioxide distension is a result of the breakdown of the canned product. It is a very common occurrence in canned syrups and molasses. For some unknown reason, but perhaps because of the high carbohydrate content, these items break down and release carbon dioxide, which causes the cans to swell. This type of sweller is not harmful and does not make the product unaccepable.

d. Mechanical distension means that internal pressures cause stress on the can. This can result in bulging and, in severe cases, ruptured seams.

e. Filling errors produce cans that have been slightly overfilled and/or that were not adequately preheated to evict the gas or were not adequately vacuumized.

f. Distension from differential altitude occurs occasionally when small, flat-type cans (sardine cans, especially) are filled at sea level and are then shipped to a much higher altitude. This is not harmful as far as product quality goes.

16-6. **Dried Products.** Many dried products in the dry storage warehouse require inspection. Examples are cereals, dried fruits, candies, etc. All previous precautionary statements regarding temperature, humidity, and stock rotation (especially) apply as firmly to these products as they do to those in cans. The greatest hazard to dried products is insect infestation.

MODIFICATIONS

Chapters 4 & 5 of this publication has (have) been deleted in adapting this material for inclusion in the "Trial Implementation of a Model System to Provide Military Curriculum Materials for Use in Vocational and Technical Education." Deleted material involves extensive use of military forms, procedures, systems, etc. and was not considered appropriate for use in vocational and technical education.

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WORKBOOK

Veterinary Microbiology; Consumer Level Quality
Audit Program; Food Technology;
Operational Ration and Egg Inspection

SELF-TEACHING AIDS
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This workbook places the materials you need *where* you need them while you are studying. In it, you will find the Study Reference Guide, the Chapter Review Exercises and their answers, and the Volume Review Exercise. You can easily compare textual references with chapter exercise items without flipping pages back and forth in your text. You will not misplace any one of these essential study materials. You will have a single reference pamphlet in the proper sequence for learning.

These devices in your workbook are autoinstructional aids. They take the place of the teacher who would be directing your progress if you were in a classroom. The workbook puts these self-teachers into one booklet. If you will follow the study plan given in "Your Key to Career Development," which is in your course packet, you will be leading yourself by easily learned steps to mastery of your text.

If you have any questions which you cannot answer by referring to "Your Key to Career Development" or your course material, use ECI Form 17, "Student Request for Assistance," identify yourself and your inquiry fully and send it to ECI.

Keep the rest of this workbook in your files. Do not return any other part of it to ECI.

EXTENSION COURSE INSTITUTE
Air University

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ECI Form No. 17

STUDY REFERENCE GUIDE

1. *Use this Guide as a Study Aid.* It emphasizes all important study areas of this volume. Use the Guide for review before you take the closed-book Course Examination.

2. *Use the Guide for Follow-up after you complete the Course Examination.* The CE results will be sent to you on a postcard, which will indicate "Satisfactory" or "Unsatisfactory" completion. The card will list *Guide Numbers* relating to the items missed. Locate these numbers in the Guide and draw a line under the Guide Number, topic, and reference. Review these areas to insure your mastery of the course.

Guide Numbers

Guide Numbers 200 through 215

200 Introduction to Veterinary Microbiology; Structure of Cells; Bacteriology; pages 1-5

201 Fungi, Protozoans, Viruses, and Rickettsiae; Disinfection and Sterilization; The Microscope; pages 5-8

202 Laboratory Specimens; pages 8-12

203 Laboratory Procedures; pages 12-15

204 Introduction to Consumer Level Quality Audit Program (COLEQUAP); Inspection Procedures; Product Examination; Records and Reports; pages 16-23

205 Introduction to Food Technology; Purposes of Food Preservation; pages 24-26

206 Methods of Preservation; Drying; pages 26-29

207 Methods of Preservation: Refrigeration; pages 29-31

208 Methods of Preservation: Canning; Packaging; Radiation; Fermentation; Curing; Use of Food Additives; pages 31-34

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209 Packaging and Packing; Cold Storage Practices; pages 34-37

210 Dry Storage Practices; Inspection of Canned Goods; pages 37-39

211 Introduction to Operational Rations; Inspection of Operational Rations; Interpretation of Inspection Results, Disposition of Rations, and Processing of Reports; pages 40-44

212 Introduction to Egg Inspection; Quality Determination; Lot Grade Determination; pages 45-51

213 Report of Inspection of Shell Eggs (DD Form 1237); pages 51-59

214 Frozen and Dehydrated Eggs; pages 59-60

215 Glossary; pages 61-62

CHAPTER REVIEW EXERCISES

The following exercises are study aids. Write your answers in pencil in the space provided after each exercise. Immediately after completing each set of exercises, check your responses against the answers for that set. Do not submit your answers to ECI for grading.

CHAPTER 1

Objectives: To show ability to recognize certain terms and microorganisms as they relate to the veterinary service; to demonstrate an understanding of the various types of sterilization; to identify the purpose and procedures in the use of the microscope; to show ability to collecting and submitting specimens to the laboratory for analyses. and to be able to identify basic laboratory tests used for the examination of foods.

1. Define protoplasm. (1-3)

2. What are two types of protoplasm? (1-4)

3. What is one function of the cell membrane? (1-5)

4. Cell membranes are referred to as semipermeable. What does this mean? (1-5)

5. Briefly differentiate between a cell wall and a cell membrane. (1-5,6)

6. What are two functions of chromatin? (1-7)

7. What is one way in which bacteria resemble plants? (2-1)

8. What are two ways in which bacteria differ from plants? (2-1)

9. What are three shapes in which bacteria occur? (2-1)

10. You are viewing a slide under the microscope and see many bacteria shaped like little coil springs. What are they called? (2-1)

11. What is the purpose of the flagella of bacteria? (2-4)

12. How do certain bacteria protect themselves from unfavorable conditions? (2-5)

13. How can you determine if bacterial growth has occurred in a clear liquid medium? (2-7)

14. How does bacterial growth appear on a semisolid medium? (2-7)

15. In what way can you use bacterial colony characteristics? (2-7)

16. Why are selective media so named? (2-8)

17. You have a bacterial growth on a culture medium and wish to identify it more specifically; what could be added to produce an inhibitory medium or selective medium? (2-8)

18. For what purpose is a differential medium used? (2-9)

19. When we talk about such things as moisture content, acid concentration. temperature. and proper oxygen requirements in microbiology, to what are we referring? (2-10)

20. Define and list three categories of bacteria based on their temperature requirements. (2-11)

21. Why should you be concerned with psychrophylic bacteria? (2-12)

22. From a public health viewpoint, why are mesophilic bacteria of particular importance? (2-13)

23. Why does the removal of water from food sometimes prevent the spoilage of that food item? (2-17)

24. Explain the principle behind the preservation of food by altering the pH. (2-18)

25. How do aerobic and anaerobic organisms differ? (2-19)

26. Describe the oxygen requirements of facultative organisms. (2-19)

27. *Briefly* describe the differences between endotoxins and exotoxins. (2-20)

28. If a toxin is not affected by heat, what is it called? (2-20)

29. Why does cooking food not always make it safe to eat? (2-20)

30. Explain the reason for the statement–"Not all fungi are destructive or harmful." (3-2)

31. Yeasts and molds cannot produce their own food because of the lack of a specified chemical. What is this chemical and how do fungi obtain food? (3-3)

32. Explain the significance of the absence of chlorophyl in yeasts or molds. (3-3)

33. If you observed a colony of fungi with hairlike structures called hyphae, which type of fungi would be represented? (3-6)

34. Why are fungi of importance to the veterinary service? (3-7)

35. What are protozoa? (3-8)

36. How are rickettsiae transmitted to man? (3-12)

37. Define disinfection. (4-2)

38. Define sterilization and give three effective means of accomplishing this process. (4-3)

39. What is the proper time and temperature for sterilization of glassware by use of a dry hot air oven? (4-5)

40. What is the name of the piece of equipment you would use to sterilize items with steam under pressure? Describe the process. (4-6)

41. What types of products can be sterilized by filtration? (4-7)

42. Differentiate between a germicide and an antiseptic. (4-8)

43. Explain the best way to avoid damaging the microscope objectives when viewing a slide. (5-3)

44. What is the name of the only liquid agent which should be used to clean the lenses or objectives of a microscope? (5-4)

45. What, and in what quantity, preservative should be added to ground or boneless beef in order to prevent decomposition during transit to a distant laboratory in warm weather? (6-2; Table 1)

46. When collecting bacterial specimens for laboratory analyses, what precaution must you take? (6-4)

47. When submitting a serum specimen for viral studies, what method of preservation is used? (6-7)

48. What is the number and title of the form used to request a laboratory analysis of fresh pork sausage? (6-9)

49. What category of laboratory test would you perform to determine the percent of butterfat, a primary ingredient of dairy products, in a shipment of ice cream? (7-3)

50. Why should a veterinary inspector be concerned with the pH of the *liquor* of a shipment of oysters? (7-4)

51. In a field situation, how should you determine the pH of oyster liquor? (7-5)

52. If your veterinary office receives a food sample for testing, but you will not be able to run the tests until the next day, what should you do? (7-7,*b*)

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CHAPTER 3

Objectives: To show knowledge of purposes of food preservation, types of preservation, use of food additives, packaging and packing of food, storage practices—and use of these facts in inspection practices.

1. List some advantages of using preserved foods. (11-1)

2. What is food spoilage? (11-2)

3. List the factors that affect food spoilage. (11-3-14)

4. Name and give four examples of a type of food which has a spoilage pattern that demands processing and/or refrigeration for storage. (11-3)

5. During decomposition of a particular food, nitrogenous compounds with an obnoxious odor are liberated. What class of nutrients is the source of this order? (11-5)

6. Briefly relate how you would recognize bacterial breakdown of the various food nutrients. (11-5)

7. Name some factors that can be controlled to lessen food spoilage caused by bacterial action. (11-4-9)

8. What is the source of the enzymes normally causing spoilage? (11-12)

9. Why are antioxidants often added to fatty foods? (11-13)

10. Generally, how do disease producing organisms affect foods? (11-14)

11. What are some of the causes of chemical spoilage foods? (11-15)

12. List the areas where possible contamination of foods might occur. (11-17)

13. A food has been preserved by drying and its water content reduced to one-fourth (25 percent). Name two classes of microorganisms that will *not* grow in this food. (12-2)

14. Name three *disadvantages* associated with atmospheric, vacuum, and freeze drying. (12-3)

15. Briefly describe the washing step during egg processing. (12-5)

16. Which two unit operations involved in drying foods (by any method) are of special significance because they are a possible source of contamination? (12-6,7)

17. What is the purpose of blanching fruits and vegetables before drying? (12-8)

18. List the methods of atmospheric drying. (12-10)

19. What are the *disadvantages* of sun drying? (12-11)

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20. What types of produce lend themselves to sun drying? (12-11)

21. How much is the moisture content reduced during sun drying? (12-11)

22. Which method of drying is usually used for the preservation of fruits and vegetables? (12-13)

23. What type of foods would be preserved by the vacuum drying technique? (12-16)

24. Name the six steps of freeze drying in order of accomplishment. (12-17)

25. Briefly describe what is meant by sublimation. (12-17)

26. What conditions are necessary for sublimation to occur? (12-19)

27. In freeze dehydration, why is the vacuum usually broken in an atmosphere of dry nitrogen? (12-22)

28. List the advantages of foods preserved by freeze dehydration. (12-23)

29. What types of foods can be freeze dried? (12-23)

30. Differentiate between the time required for rehydrating a freeze-dried food as compared with one that was dehydrated by other means. Why is this so? (12-24)

31. Why is it important to prevent the accidental rehydration of freeze dried foods? (12-25)

32. What consideration should be made when selecting containers for fruits, vegetables, and meats? (12-26)

33. What precaution regarding safety of personnel must be observed in the use of dry ice in the chill or freezer room? (12-29)

34. Name two ways of packaging that will avoid freezer burn of meat. (12-32)

35. Contrast the quick method with the sharp method of freezing foods as to size of ice crystal and bacterial growth. (12-34,35)

36. What are the results of temperature fluctuations in frozen foods? (12-37)

37. What effect does freezing have on microorganisms? (12-38)

38. What effect does freezing have on enzymatic activity? (12-39)

39. Why is it that frozen foods stored under optimum conditions do *not* retain their quality indefinitely? (12-40)

40. With the food's condition being excellent, what is the determining factor as to which frozen foods are to be issued first? (12-42)

41. Contrast the thawing of frozen beef and pork with the thawing of fish and vegetables. Tell why they differ. (12-43)

42. Why does the Air Force *not* permit the refreezing of foods that have accidentally been thawed? (12-44)

43. What is the proper disposition of frozen foods that have thawed and whose temperature has exceeded 40° F for 4 hours? (12-45)

44. In terms of individual rations, what is a benefit of canning as a means of food preservation? (12-49)

45. What is the purpose of the heat processing step in canning? (12-50)

46. What is the benefit of asceptic canning? (12-52)

47. What food items are preserved using aseptic canning method? (12-52)

48. What are the *disadvantages* of glass food containers? (12-53)

49. Where, how, and for what is zinc used in the canning process? (12-55)

50. What two radiation sources are used to irradiate foods? (12-58)

51. What is the upper limit of exposure to gamma rays now used in food processing? Give a *disadvantage* of its use. Give two *advantages* of using it on pork products. (12-58)

52. What change in pH occurs in food undergoing preservation by fermentation? How does this change affect pathogens? (12-59)

53. What is the primary objective of curing meats? (12-62)

54. How does curing prolong the keeping quality of meat? (12-62)

55. State a *disadvantage* of using salt as a preserving food additive. (12-64)

56. Why is sodium nitrate and potassium nitrate added to fresh meats to be cured? (12-66)

57. What effect does nitrite have on meat color? (12-67)

58. What are the objectives of smoking meat? (12-70)

59. Name three things that a food additive must *do* and three things that it must *not* do. (12-71)

60. How might some of the dangers of serving potato salad be eliminated? (12-73)

61. Name two antibiotics approved for use on dressed poultry. (12-76)

62. For what are sulfur compounds used in the preservation of foods? (12-77)

63. What factors may accelerate oxidative rancidity? (12-79)

64. What governmental agency regulates and approves substances to be added to foods? (12-82)

65. Name a food additive (other than an antibiotic) whose use in meats is forbidden. Tell why it is forbidden. (12-83)

66. What is packaging and what is its overall purpose? (13-1,2)

67. The dimensions (in inches) of a can are 308 x 512. Which number represents the height and which the diameter? (13-3)

68. Define "packing" and give several reasons for packing foods. (13-5)

69. Why are standard markings for perishable subsistence *not* placed on fresh-fruits and vegetables? (13-7)

70. What foods should be placed in the freezer storage room of a cold storage plant? (14-3)

71. Why would you suggest refrozen food items be marked for identification? (14-4)

72. What special precautions are to be made when storing fresh pork and pork sausage? (14-5)

73. Why are items such as dairy products, eggs, and lard stored separately from fruits and vegetables? (14-6)

74. When stacking food items in a dry storage warehouse, what are the recommended clearances or air spaces between the items and the floor and ceiling? (14-9)

75. List the observable points to be checked while conducting an inspection of a nonperishable storage facility. (15-1)

76. What products in a dry storage warehouse are particularly vulnerable to freeze damage during cold weather? (15-3)

77. What dry storage products are *most* likely to be infested with insects and rodents? (15-5)

78. What is epidemic spoilage? (15-7)

79. Give the four codes (and the conditions that they indicate) which are used to designate the condition of foods examined on a Class 5 inspection. (16-1)

80. Contrast a major can defect with a minor can defect. (16-3)

81. Which major defect concerning distended cans would be *most* difficult to detect? Name four likely causes. (16-5)

MODIFICATIONS

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ANSWERS FOR CHAPTER REVIEW EXERCISES

CHAPTER 1

1. Protoplasm is a complex mixture of protein molecules, fat globules, inorganic salts, sugars, and amino acids in water. Many consider it to be the living substance that makes up cells.
2. Cytoplasm and nucleoplasm.
3. Allows for the selective passage of materials into and out of the cell.
4. The cell membrane allows only certain materials to pass through into and out of the cell.
5. The cell wall of plant cells, made of cellulose, gives the cell rigidity. The cell membrane is primarily a structure which controls the movement of material in and out of the cell.
6. Chromatin controls all activity of cells and carries inheritance factors of a cell.
7. They have a rigid cell wall.
8. A bacterium doesn't contain chlorophyl or a well-defined nucleus.
9. Round (cocci), rod-shaped (bacilli), and spiral-shaped (spirilla).
10. Spirilla.
11. It provides a means of movement.
12. By condensing their cytoplasm into spores.
13. The medium turns cloudy.
14. As a visible colony.
15. As a means of identifying the bacteria.
16. These media allow for the growth of some types of microorganism but inhibit the growth of others.
17. NaCl.
18. Identification of the microorganism.
19. Environmental requirements for bacterial growth.
20. Psychrophilic (cold loving), Mesophilic (medium temperature loving). Thermophilic (heat loving).
21. When present in food, they cause undesirable flavors and decrease keeping qualities.
22. Pathogenic bacteria fall within this group.
23. Bacteria, the cause of much food spoilage, require moisture to live.

24. There is a narrow range of pH in which bacteria will grow. If the pH is altered, the bacteria cannot multiply.

25. Aerobic organisms require atmospheric oxygen to survive. Anaerobic organisms do not require atmospheric oxygen.

26. They can live in the presence or absence of atmospheric oxygen.

27. Endoxins are bacteria that die and break up and release toxins from inside the cell, whereas exotoxins are toxins produced by luring organisms.

28. Thermostable.

29. Thermostable toxins could still be present in the food.

30. Many are beneficial to man; the production of some alcohols, cheeses, bakery goods, and antibiotics are made possible by the action of fungi.

31. Chlorophyl. From dead or dying matter, manufactured food products, or a living organism.

32. Yeasts and molds have to attack dead or dying matter, manufactured food products, or living matter.

33. Molds.

34. Fungi are very prevalent in nature and are associated with diseases, as well as food spoilage, medicine production, and industrial uses in food production.

35. One-celled and the simplest form of animal life.

36. By the bite or the excreta of anthropod vectors.

37. The killing or removal of microorganisms that could cause infection.

38. Sterilization is destroying all living microorganisms by using heat, mechanical means, or chemical means.

39. Two hours at 338° F.

40. Autoclave. It is used at 15 pounds per square inch of pressure for approximately 15 to 20 minutes, the temperature being 250° F.

41. Liquids.

42. Germicides kill all bacteria present; whereas, antiseptic solutions only prevent reproduction and don't always work.

43. Observe from the side while you are lowering the objective to a position close to the slide.

44. Xylol.

45. To prevent decomposition during warm weather, all 2 ml formalin per pound.

46; Use sterile instruments and your best sterile techniques.

47. Serum specimens should be frozen immediately and should be kept frozen until they reach the laboratory.

48. DD Form 1222, Request for and Results of Tests.

49. Chemical.

50. The pH is measured to determine the quality of the shipment.

51. With use of a Taylor Slide Comparator.

52. Refrigerate the sample between 0° C. and 4° C. or freeze if the sample is a frozen product.

CHAPTER 3

1. Seasonal foods are available all year round, surplus foods can be stored for times of shortage, and foods can be moved to areas of shortage or nonexistence.

2. Food is considered spoiled when microorganisms and enzymes break down the organic material of its structures and alter it to such an extent that discriminating people will not accept it for consumption.

3. Food composition, microorganisms, enzymes, oxidation, and chemicals.

4. Perishable foods including all meats, fruits, vegetables, milk, and eggs.

5. Protein.

6. Protein breakdown by bacteria produces nitrogenous compounds with obnoxious odors; carbohydrates are acted upon to produce a sour, gaseous type of spoilage; and fats decompose to cause a cheesy or rancid odor.

7. Limiting moisture content (including dehydration), controlling acidity (pH), controlling salt content, and controlling temperature and similar environmental factors.

8. The enzymes are normally present in the food materials themselves.

9. To reduce spoilage caused by oxidation.

10. Very little, if any, change in the flavor, odor, or consistency.

11. Highly acid foods reacting with the can, sulfur-containing foods reacting with other food components, and the release of carbon dioxide in canned syrups and molasses.

12. During harvesting, during the canning process, and during transit or storage if rough handling causes damage, or insects or rodents penetrate the containers.

13. Bacteria and yeast.

14. Takes a long time to rehydrate, the flavor of food is lost or changed, and the color darkens.

15. Washed in 0.5 to 2.0 percent lye water.
16. Trimming and dividing.
17. Makes them easier to peel, cleans them, shrinks them, and stops enzymatic activity.
18. Sun drying, kiln drying, tunnel drying, drum drying, and spray drying.
19. The drying is subject to the whims of the weather, and the food is exposed to possible contamination.
20. Apricots, peaches, plums, and grapes.
21. To a range of 18 to 24 percent.
22. Tunnel drying.
23. Those foods which would be damaged by high processing temperatures: for example, coffee, milk, fruit juices.
24. Freezing, vacuumizing, heating, removing vapor, breaking the vacuum, and packaging.
25. Ice being transformed into a vapor without passing through the liquid stage.
26. A rise in temperature under a controlled atmospheric pressure.
27. Because if oxygen is present, the fat in meats can become rancid.
28. Equals the storage life of canned goods and surpasses them in quality, reduces transportation costs.
29. Meats, fruits, vegetables, and numerous seafoods.
30. Less time is required for rehydrating a food that is freeze-dried than one that is only dehydrated, because freeze-drying leaves the food more porous and the cell structure less damaged and distorted.
31. Because spoilage will begin immediately.
32. They should prevent damage, contamination, and spoilage. They should be waterproof and lightproof.
33. Leave the door open when you enter the room, since melting dry ice liberates pure carbon dioxide and causes a shortage of life-essential oxygen.
34. Select a gas-impervious package and avoid air pockets adjacent to and around the meat.
35. In the quick method, bacteria have less time for growth, and small (instead of large) ice crystals are formed. Large crystals cause breakdown of cells, loss of fluid, and eventually (upon being thawed) dry-tasting food.
36. Large ice crystal formation and acceleration of enzymatic chemical reactions.

37. Even though the organisms might stop reproducing while in the frozen state, they will start again when the food is thawed.

38. Freezing slows the action of enzymes but does *not* destroy them. When food is restored to normal temperature, the enzymes resume their activity.

39. Because chemical reactions in the food continue even in the frozen state.

40. The date that the products were received (first in–first out).

41. Beef and pork should be thawed slowly, rather than by rapid cooking. Slow thawing allows the cells to reabsorb moisture lost during freezing. Fish should be thawed rapidly, preferably by cooking, since slow thawing may denature fish protein. Thawing by cooking is a must for frozen vegetables and certain fruits.

42. The Air Force only has freezer facilities to maintain previously frozen food, *not* to quickly refreeze thawed food. Thus, since the food would have to be slowly refrozen, it would have time to deteriorate and to develop off-odors.

43. Condemn the food.

44. They can be easily preserved and used at any place, including in combat rations; and the sealed cans protect the food from any type of contamination including nuclear, chemical, and biological contamination.

45. It destroys any undesirable microorganisms present, cooks the food, and stops enzymatic activity.

46. A product with an extremely long shelf life (keeping qualities).

47. Milk and other dairy products such as ice cream mixes.

48. They break easily and the food in them cannot be processed under high temperatures and pressures.

49. Fifteen percent of finely powdered zinc oxide is used in making a "C" enamel to line the inside of cans for corn, meat, fish, and poultry products to prevent objectionable formation of black tin and iron sulfides resulting from protein breakdown reacting with the metal.

50. Electron radiation and gamma rays.

51. 1,000,000 rads can cause certain foods to lose quality, but when applied to pork, it kills trichina and preserves bacon.

52. As a food ferments, its pH decreases. The pH of fermented foods is adequate to prevent growth of all pathogens.

53. It is a means of preserving meat and giving a particular flavor.

54. The tissue is saturated with salt, which eventually destroys most of the microorganisms.

55. It destroys the natural color of meat.

56. They act as reservoirs for nitrites.

57. The nitrite unites with hemoglobin to form nitric oxide myoglobin which, in the presence of heat, yields nitric oxide myochromogen, a stable color.

58. Remove moisture, impart a smoked flavor, stabilize a cured color, prevent oxidative rancidity, and kill surface bacteria.

59. A food additive must improve the food, be easily identified, and be proven safe before use. It must *not* injure the consumer, reduce action of digestive enzymes, nor react to form harmful compounds in the body.

60. By the addition of highly acid substances, therefore lowering the pH.

61. The antibiotics terramycin and aureomycin may be used on poultry.

62. They are most effective against molds in the preservation of acid fruits and vegetables.

63. Light, air, moisture, heat, and catalysts such as copper.

64. Food and Drug Administration.

65. Sodium sulfite is forbidden because it is toxic.

66. Food is placed in an individual can or container to protect the food, and as a convenience in its use and handling.

67. Its diameter is 3 9/16 or 3 1/2 inches; its height is 5 13/16 or 5 3/4 inches.

68. Packing is the grouping of a number of small packages or units into one larger unit or pack. Reasons for packing food are to protect against mechanical damage, loss, pilferage, dirt, contamination, moisture or other conditions which may affect the wholesomeness or storage life of foods.

69. Ordinarily they would not be appropriate. Such markings as are specified in the contract or purchase order are placed thereon.

70. All food that is frozen when it is received will be stored here at a temperature of 0° F. to -10° F., which is *not* (preferably) allowed to fluctuate.

71. So that they could be used before the other foods that had not been refrozen.

72. Since they require a lower storage temperature, they should either be stored in a separate meat chill room or in the coldest part of the beef chill room for no longer than 48 hours.

73. To prevent the transfer of taste and odors.

74. Four to six inches between the stacks and the wall and 18 inches between the top of the stack and ceiling.

75. The use of pallets, heating facilities, ventilation, security, insect and rodent control, storage charts, markings, and epidemic spoilage.

76. Glass containers and liquid canned goods.

77. Flour, dry beans, rice, raisins, macaroni, spaghetti, noodles, and cereals.

78. This is spoilage that occurs when a can or cans in a stack of cases rupture and the contents leak on cases and cans that are stored below.

79. Code A means prime quality; Code B, intermediate quality; and Code C, that the product should be issued as soon as received and not held for any extended period of time. Code X is given to those products which are shipped to preclude a complete loss to the Government.

80. A major defect can result in failure or can materially reduce the usability of the unit (can and contents). A minor defect does not materially reduce the usability of the unit, but either departs from an established standard or else limits its serviceability.

81. A flipper is a can with too little vacuum. The causes are overfilling, insufficient exhaustion, chemical action, and bacterial action.

MODIFICATIONS

Pages 29 - 41 of this publication has (have) been deleted in adapting this material for inclusion in the "Trial Implementation of a Model System to Provide Military Curriculum Materials for Use in Vocational and Technical Education." Deleted material involves extensive use of military forms, procedures, systems, etc. and was not considered appropriate for use in vocational and technical education.

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VETERINARY SERVICES SPECIALIST

(AFSC 90850)

Volume 3

Meat Inspection

Extension Course Institute

Air University

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Preface

AN IMPORTANT responsibility of the veterinary specialist is the inspection of meat to be used for human consumption. Meats requiring inspection are beef, veal, lamb, pork, and poultry. The processing of these meats is the primary subject of this volume.

The anatomy of the food animal is discussed in the first chapter. In the succeeding chapters we will discuss beef, veal (and calf), lamb, pork, sausage, and poultry.

If you have questions on the accuracy or currency of the subject matter of this text, or recommendations for its improvement, send them to School of Health Care Sciences, USAF (ATC) MST/114, Sheppard AFB TX 76311.

If you have questions on course enrollment or administration, or on any of ECI's instructional aids (Your Key to Career Development, Study Reference Guides, Chapter Review Exercises, Volume Review Exercise, and Course Examination), consult your education officer, training officer, or NCO, as appropriate. If he can't answer your questions, send them to ECI, Gunter AFB AL 36118, preferably on ECI Form 17, Student Request for Assistance.

This volume is valued at 21 hours (7 points).

Material in this volume is technically accurate, adequate, and current as of March 1973.

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Anatomy of Food Animals

IN THE UNITED STATES, the US Department of Agriculture (USDA) usually performs all antemortem and postmortem inspections and most of the meat grading for the Armed Forces. In oversea areas where meats are sometimes procured from other countries, it may be necessary for Armed Forces veterinary personnel to perform the inspections or to evaluate the inspections of the foreign country.

2. The anatomy of beef, veal, lamb, and pork will be our primary concern here. We are limiting our discussion to these because they are very similar in those aspects of anatomy that concern you in your inspection responsibilities. Though "anatomy" includes much more, it is essential that you have at least an understanding of the skeleton, the muscles, and the nervous, digestive, lymphatic, respiratory, and urinary systems.

3. We will concentrate on these areas. As we consider each anatomical structure, we will refer to accompanying illustrations. For complete understanding, examine these figures as the text indicates.

1. Skeletal and Muscular Anatomy

1-1. The smallest units of an animal body are cells. When they are bound by intercellular substance, they form tissues.

1-2. Cells. There are five types of cells: epithelial cells, connective tissue cells, blood cells, muscle cells, and nerve cells.

1-3. *Epithelial cells.* These cells form tissues that cover and protect the body. Examples are skin, hair, hoofs, and feathers. These cells also form tissues that line body cavities, such as the serous and mucous membranes.

1-4. *Connective tissue cells.* These cells hold specialized cells together to form tissues and organs. Cells forming the framework of cartilage, bone tendons, and ligaments are examples.

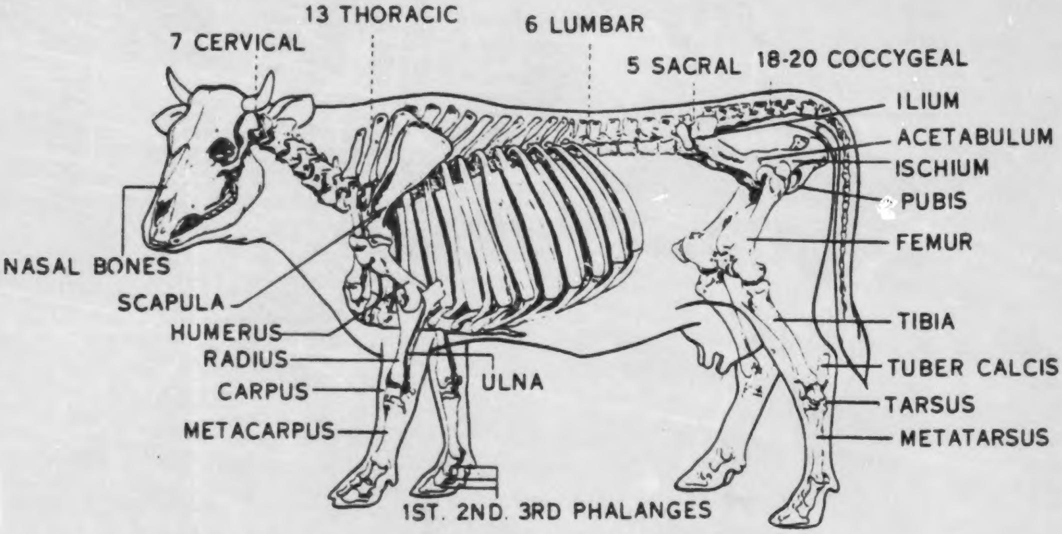

13 THORACIC
6 LUMBAR
7 CERVICAL
5 SACRAL
18-20 COCCYGEAL
ILIUM
ACETABULUM
ISCHIUM
PUBIS
FEMUR
NASAL BONES
SCAPULA
HUMERUS
RADIUS
CARPUS
METACARPUS
ULNA
TIBIA
TUBER CALCIS
TARSUS
METATARSUS
1ST. 2ND. 3RD PHALANGES

Figure 1. Bovine skeleton.

1-5. *Blood cells.* These are mobile and move through the bloodstream. Examples of these are red and white blood cells.

1-6. *Muscle cells.* These compose fibers that constitute the muscle tissue.

1-7. *Nerve cells.* When nerve cells are banded together, they form nerves. The nerves are of several types: the central system nerves (brain and spinal cord); the peripheral nerves, which supply skin and appendages; the motor nerves, which supply muscles of locomotion; and the sympathetic nerves, which provide automatic reflex action.

1-8. Tissues. In considering the tissues, we will briefly discuss the epithelial tissues and the connective tissues.

1-9. *Epithelial tissues.* Epithelial tissues may be categorized into *internal* and *external* epithelium. External epithelial tissue is the skin (hide) of the animal. Internal epithelium lines the cavities of the body and is divided into *mucous* membrane and *serous* membrane. Mucous membrane lines those body cavities that have external openings. These include the digestive and reproductive tracts. Serous membrane lines the two enclosed cavities of the body. The serous membrane that lines the thoracic cavity is called *pleura* and that which lines the abdominal cavity is called *peritoneum.*

1-10. *Connective tissues.* These vary in consistency and chemical composition. Some examples are fatty tissue (such as the fat marbling in beef), white fibrous tissue (in ligaments and tendons), yellow elastic tissue (in the ligamentum nucha (backstrap) in the neck region), cartilage (in the buttons at the end of the dorsal spine of the vertebrae), and bone, the supporting framework of the body.

1-11. Skeletal System. In considering the skeletal system, we will divide it into three components: the axial, appendicular, and joints. Refer to figure 1 as we discuss these three components of the skeletal system.

1-12. *Axial skeleton.* This includes the skull, vertebral column, ribs, and sternum. The bovine skull consists of 29 bones, many of them fused. The skull as such is not especially significant in meat inspection, but you must remember certain landmarks when you are performing such necropsy procedures as removing the brain for the diagnosis of rabies or listeriosiu.

1-13. The vertebral column consists of irregular bones (vertebrae) extending from the skull to the tail. This acts as a beam in supporting the animal body. The column surrounds the spinal cord and is divided into five regions:

a. Cervical vertebrae (C). Cattle have seven of these vertebrae. These are the first vertebrae in the vertebral column.

b. Thoracic vertebrae (T). Cattle have 13 of these. Each vertebra has a rib attached.

c. Lumbar vertebrae (L). Beef cattle have six of these. They are in the region of the loin.

d. Sacral vertebrae (S). There are five of these vertebrae, collectively called the sacrum.

e. Coccygeal vertebrae (CY) (Tail). There are from 18 to 21 of these in cattle; in other species their number varies. Of the animals which we will study, the vertebral formulae show the greatest variation in numbers of vertebrae among the coccygeal vertebrae.

1-14. Vertebral formulae serve as useful landmarks for learning cuts of edible meat, and inspection points, of food animals. Below are the vertebral formulae for the bovine, pig, sheep, and chicken:

- Bovine - $C_7 T_{13} L_6 S_5 CY_{18-21}$
- Pig - $C_7 T_{14-15} L_{6-7} S_4 CY_{20-23}$
- Sheep $C_7 T_{13} L_{6-7} S_4 CY_{16-19}$
- Chicken - $C_{14} T_7 L\&S_{14} CY_6$

1-15. Ribs are long, curved, somewhat flattened bones, which junction (articulate) with thoracic vertebrae. Cattle have eight pairs of sternal ribs and five pairs of asternal (floating) ribs.

1-16. The sternum is the breastbone; it consists of seven bones called sternebrae. They are separated by cartilage in the young animal, but are fused into solid bone in the older animal.

1-17. *Appendicular skeleton.* The appendicular skeleton includes the bones of the pelvic limbs and the thoracic limbs. The thoracic limb of an animal corresponds to the human arm; the pelvic limb to the human leg.

1-18. Beginning with the bones of the foreleg, the scapula (bladebone) is a flat bone that lies on the lateral anterior surface of the thorax. The humerus (armbone) is a long bone that articulates with the scapula and the radius. The radius and ulna (forearm) are long bones that articulate with the humerus and the carpus. The ulna projects dorsally and posteriorly to form a prominence called the elbow. The carpus is commonly referred to as the *knee* in animals. It consists of six bones arranged in two layers and is the anatomical division between the foot and the leg. This group of bones is comparable to the bones in the human wrist.

1-19. The metacarpus (shinbone) is a long bone that articulates with the carpus and phalanges. The distal epiphyseal joint (break joint) is cartilaginous in lamb and ossified in

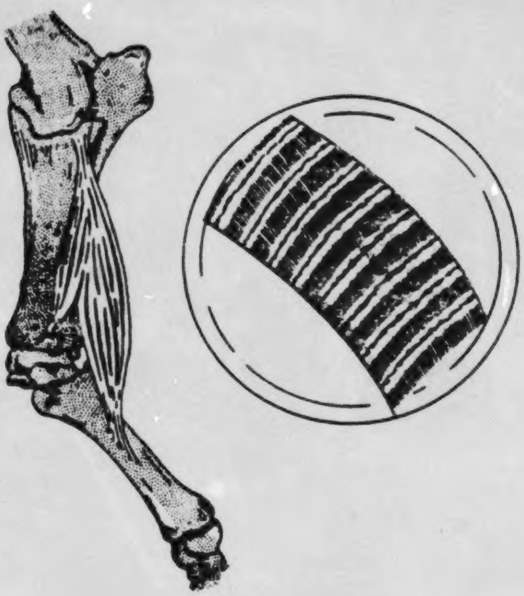


Figure 2. Voluntary muscle and muscle fiber.

mature sheep. The phalanges (digits) have six phalanx bodies and six sesamoid bones. The third phalanx forms the hoof in the horse. It is comparable to your middle finger. The other phalanges compare to the bones in your hand.

1-20. Turning now to the bones of the pelvis and hindleg, the pelvis consists of three pairs of flat, fused bones—the ilium, ischium, and pubis. The pubis is the middle part of the pelvis. The fusion of this middle portion is called the symphysis pubis. When a carcass is split in the middle, the symphysis is exposed and this bone is commonly called the aitchbone. The aitchbone is an important landmark in inspection procedures, such as for sex determination and proper cutting methods. The femur is a long bone that has a proximal articulation with the pelvis and a distal articulation with the patella (kneecap) and the tibia. The patella is a short bone that articulates at the distal (remotest or farthest from the point of origin or attachment) extremity of the femur. The tibia is a long bone. Its upper portion articulates with the femur and patella, and its lower end articulates with the tarsus. A rather long bone located laterally to the tibia and not easily identified as a separate bone is the fibula. This is a nonarticulating bone. The tarsus forms the backjoint and consists of five to seven short bones. It is directly below the tibia on the pelvic limb. Directly below the tarsus are the metatarsal bones. They are comparable to the metacarpus of the front leg.

1-21. *Joints*. Our discussion of joints will be brief, the objective being that of defining them. All joints can be placed in two broad categories—movable and immovable. Movable joints are classified according to type of construction and include the ball-and-socket, hinge, pivot, and gliding joints. Ball and socket joints are those in which the rounded end of one bone fits into a hollow in the surface of another. Such a joint permits a greater degree of motion than do the others. The hip joint is a particularly good example of this type of joint, with the femur fitting into a socket in the pelvis. Hinge joints, such as the knee, permit movement of one bone about the transverse axis of another. Pivot joints allow one bone to rotate around another that remains stationary. There is a pivot joint between the first and second bones of the vertebral column. This joint is partially visible in figure 1. Gliding joints permit little motion except that provided by one bone sliding a short distance over the surface of another. The closely packed bones of the carpus are an example of a gliding joint. Immovable joints are fixed articulations in which there is no movement of one bone upon another, such as the bones of the skull. They are fixed with the joint between them called the suture.

1-22. Muscular System. The muscular system is composed of highly specialized organs that contract when they are stimulated. There are two classifications of muscles—voluntary (controlled by the will) and involuntary (not controlled by the will).

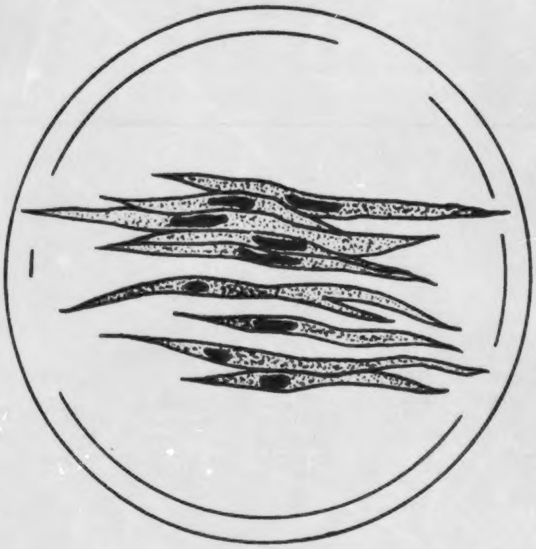


Figure 3. Involuntary muscle fiber.

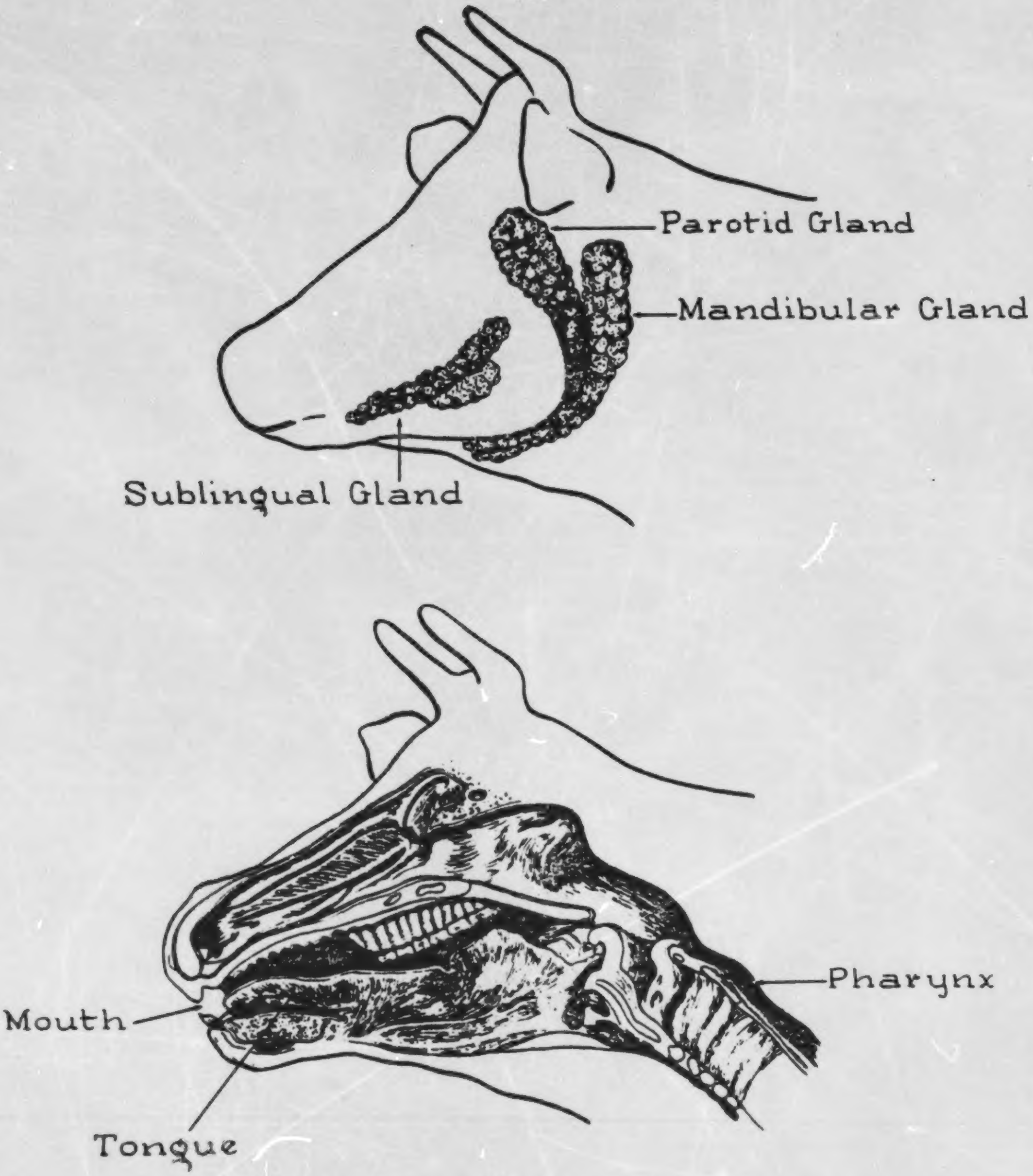


Figure 4. Digestive system of the bovine.

Refer to figures 2 and 3 as we discuss these two components of the muscular system.

1-23. *Voluntary muscles.* When voluntary muscle tissue is examined under a microscope, it displays alternate dark and light bands which run across the muscle fibers. This type of muscle is also called skeletal or striated muscle. Figure 2 shows a voluntary muscle and a voluntary muscle fiber.

1-24. *Involuntary muscles.* Involuntary muscle includes smooth and cardiac muscle. Smooth muscle (fig. 3) does not have striations. It is responsible for the movement of the viscera during digestion and the action of the blood vessels and glands. Cardiac muscle is found only in the heart. Unlike smooth muscle, it does have striations, but it is still involuntary in action. It is responsible for the pumping action of the heart.

1-25. Now, take a closer look at some important muscles:

a. Extensors and flexors. For every group of muscles that produces a motion (extensor), another group produces an opposite motion (flexor).

b. Back muscles. The development of these muscles is important in food animals because this area is the source of choice meat.

c. Abdominal muscles. These muscles are important in supporting viscera, in respiration, and in expelling feces.

d. Diaphragm. This is a structure that separates the abdominal and thoracic cavities. When the diaphragm contracts, air is inhaled into the lungs; when it relaxes, air is exhaled. Since early deterioration may begin under the diaphragm, this muscle is an important landmark for checking the condition of meat carcasses.

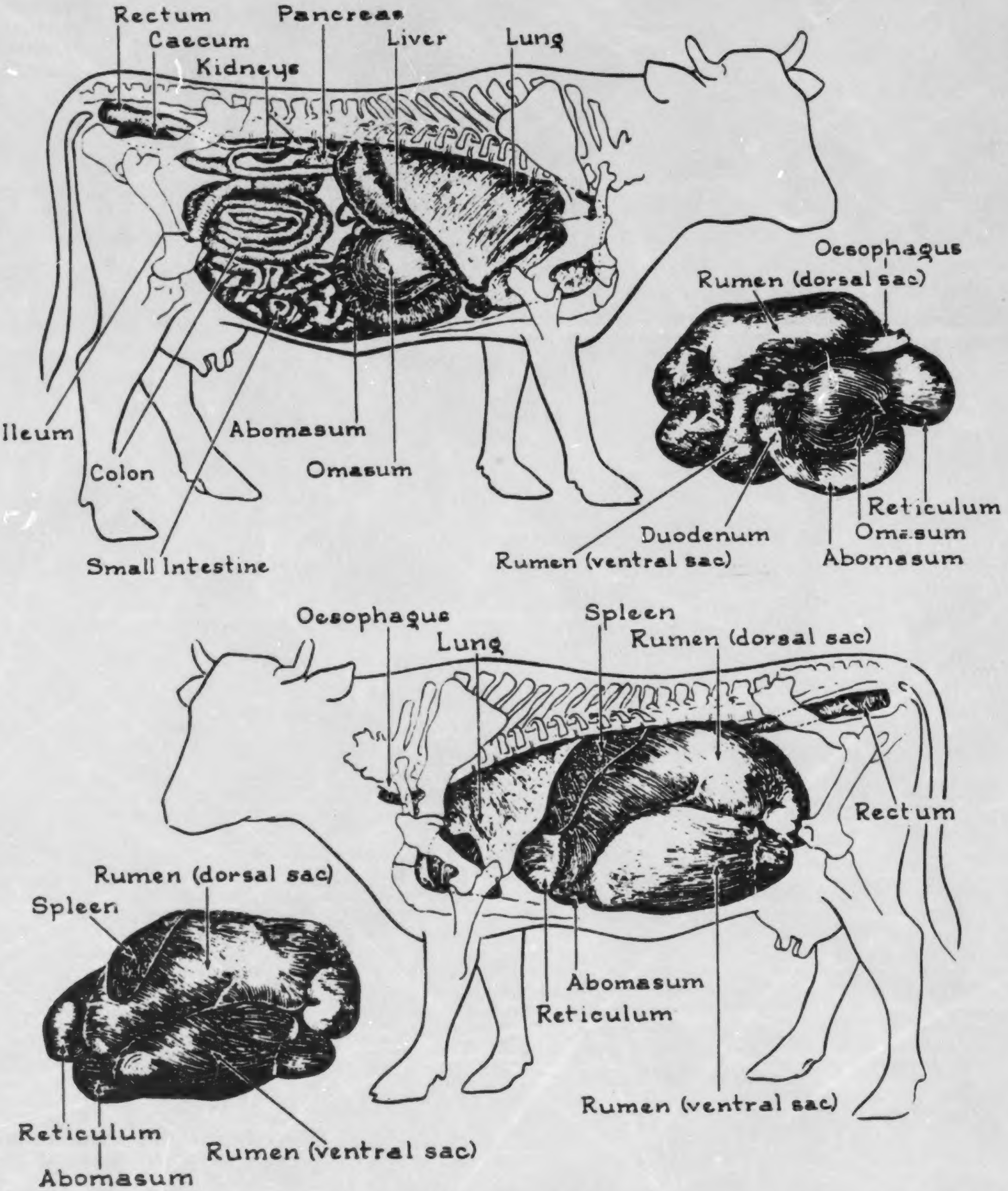

Rectum
Pancreas
Caecum
Liver
Lung
Kidneys
Oesophagus
Rumen (dorsal sac)
Ileum
Abomasum
Colon
Omasum
Reticulum
Duodenum
Omasum
Small Intestine
Rumen (ventral sac)
Abomasum
Oesophagus
Spleen
Lung
Rumen (dorsal sac)
Rectum
Rumen (dorsal sac)
Spleen
Abomasum
Reticulum
Rumen (ventral sac)
Reticulum
Rumen (ventral sac)
Abomasum

Figure 5. Digestive system of the bovine (cont'd).

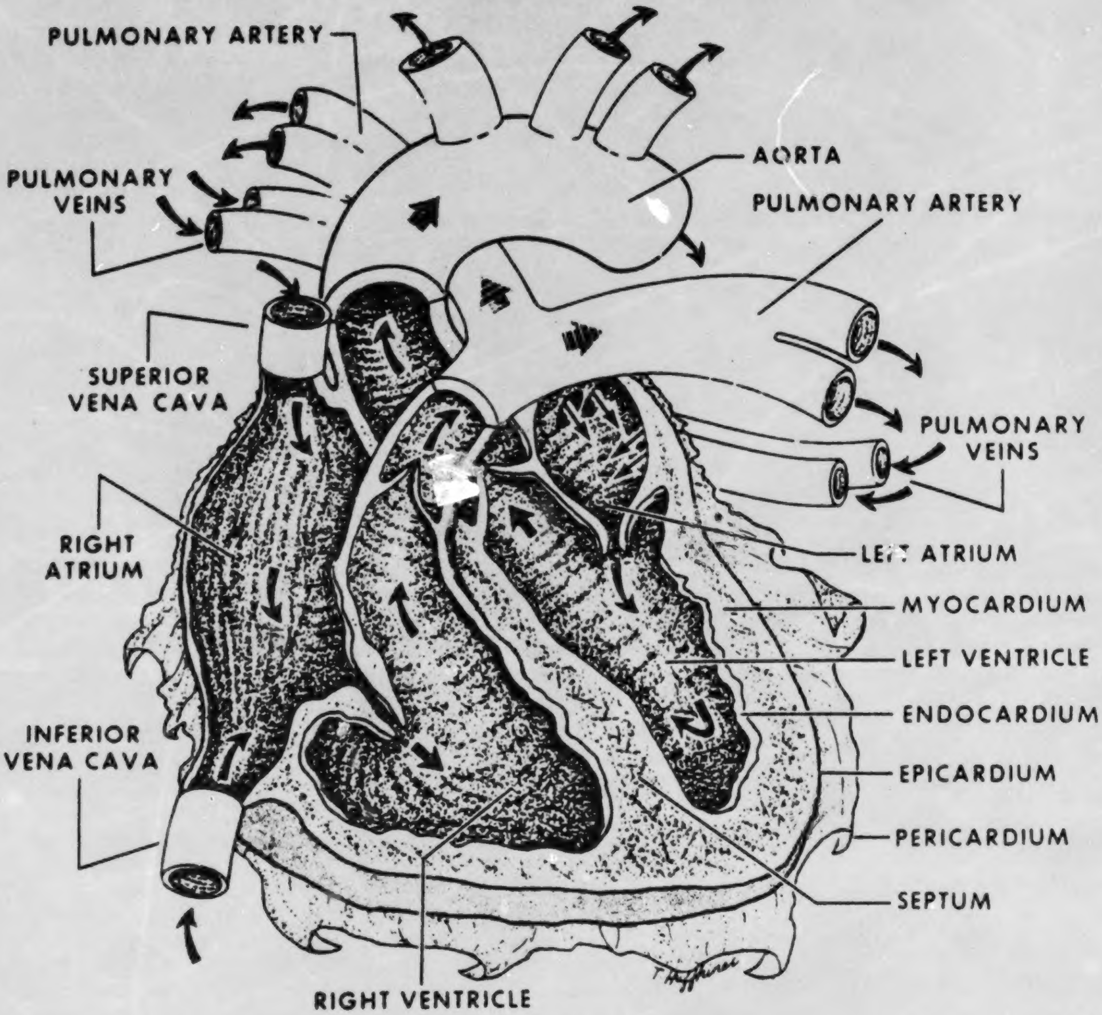

PULMONARY ARTERY
PULMONARY VEINS
SUPERIOR VENA CAVA
RIGHT ATRIUM
INFERIOR VENA CAVA
RIGHT VENTRICLE
AORTA
PULMONARY ARTERY
PULMONARY VEINS
LEFT ATRIUM
MYOCARDIUM
LEFT VENTRICLE
ENDOCARDIUM
EPICARDIUM
PERICARDIUM
SEPTUM

Figure 6. Heart.

2. Nervous, Digestive, Circulatory, Lymphatic, Respiratory, and Urogenital Systems

2-1. Though you may not realize it, your responsibilities in meat inspection require a knowledge of all these systems. We will discuss the nervous, digestive, circulatory, lymphatic, respiratory, and urogenital systems as they relate to meat inspection.

2-2. **Nervous System.** The brain is the only nervous tissue that is used for food. A knowledge of the nervous system is important in identifying certain diseases in food animals and working animals. The system is divided into a central and a peripheral system.

2-3. *Central system.* This consists of the brain and the spinal cord. The brain can store information, generate thoughts, and determine reactions that the body should perform in response to the sensations. Appropriate signals are then transmitted through the spinal cord to the peripheral system.

2-4. *Peripheral system.* The peripheral nervous system consists of the cranial nerves and the spinal nerves. There are 12 pairs of cranial nerves. The spinal nerves are arranged in pairs, and named to accord with their relationship to the vertebral column. These are *cervical, thoracic, lumbar, sacral,* and *coccygeal.* The spinal nerves are connected to the spinal cord by a ventral root and a dorsal root.

2-5. There are two kinds of nerve fibers. Those that enter the dorsal root of the spinal cord are the sensory nerves, and carry impulses to the central nervous system. The motor nerves enter the ventral root and carry motor impulses to all parts of the body.

2-6. **Digestive System.** The only digestive system we will discuss here is that of the bovine. The bovine system includes the alimentary canal, which runs from the mouth to the anus, and the accessory organs (the salivary glands, liver, pancreas, and gallbladder). In this system, both mechanical and chemical processes take place to make food usable by the body. The mechanical actions are chewing, swallowing, regurgitation peristalsis (alternate contraction and relaxation), and defecation. The chemical reactions are the breakdown of foods by gastric juices and enzymes to make them usable by the cells of the body. As we discuss the following structures of the digestive system, refer to figures 4 and 5.

2-7. *Mouth.* The main functions of the mouth are prehension (grasping) and mastication (chewing) of food. The teeth and tongue help in both functions. The age of the animal can be reasonably determined by certain characteristic changes that occur in the animal's teeth.

2-8. *Salivary glands.* Three major salivary glands are located in the head region. They secrete saliva for the liquid and alkalinity in the stomach. These glands are:

a. Parotid salivary gland. This is the largest gland, and is located in the upper part of the cheek below the ear.

b. Mandibular salivary gland. This gland is located just back of the mandible.

c. Sublingual salivary gland. It is located medial to the mandible.

2-9. *Pharynx, esophagus, and stomach.* The pharynx is a canal that leads from the nose and mouth to the esophagus. When food is about to be swallowed, the tongue pushes it back, the larynx is closed by the epiglottis, and the food is passed into the esophagus. The esophagus is the structure through which food passes from the mouth to the stomach. Food is moved downward by rhythmic contraction of the muscular wall of the esophagus. The bovine stomach consists of four compartments: the rumen, reticulum, omasum, and abomasum.

2-10. *Intestines.* The small intestine in the bovine is about 130 feet long. It has three parts—the duodenum, jejunum, and ileum. Digestive juices are secreted into the small intestine from the pancreas, liver, and

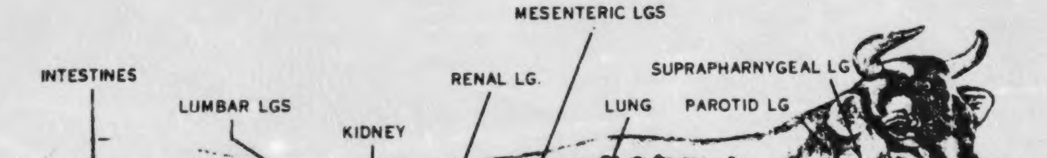


Figure 7. Location of lymph glands.

gallbladder. The bile, which is discharged from the gallbladder, converts raw fats to glycerol and fatty acids. The pancreatic juice from the pancreas aids in the digestion of protein and carbohydrates.

2-11. The ingesta passes from the small intestine to the large intestine. Between these intestines and projecting from the large one is the caecum (or cecum), where further breakdown of food occurs. The large intestine is about 35 feet long. Liquids that are not absorbed in the small intestine are absorbed here.

2-12. *Accessory organs.* These organs are the most important in the digestion system. The liver secretes bile, which is stored in the gallbladder. It converts sugar to glycogen for storage, and it changes waste products to urea for elimination by the kidneys. The pancreas secretes insulin, which controls sugar in the body. It also secretes pancreatic juice, which digests protein, carbohydrates, and fat.

2-13. Circulatory System. The circulatory system carries oxygen and food to the cells, and carbon dioxide and waste from the cells. This system is made up of the blood vascular system and the lymphatic system. The blood vascular system is the heart and its blood vessels (arteries, capillaries, and veins). The heart, shown in figure 6, has four chambers. It is divided vertically in the middle by a septum, and is divided horizontally into the upper and lower halves. A fibrous tissue called the pericardium surrounds the heart. Structures of the heart wall are the outer layer (the epicardium), the middle or muscular layer (the myocardium), and the inner layer (the endocardium). The tissues that make up the valves between the atria and the ventricles are from the endocardium.

2-14. *Blood vascular system.* The blood vessel system consists of three subsystems—the pulmonary, systemic, and portal. In the pulmonary system, the blood is passed from the right ventricle through the pulmonary artery to the lungs for oxygenation. The oxygenated blood is returned through the pulmonary vein to the left atrium. The systemic system recovers oxygenated blood through the left atrium to the left ventricle. The left ventricle pumps the blood through the dorsal aorta and its branches to the tissues of the body. The portal circulation system drains blood from the digestive tract and carries it via the portal vein to the liver. The arteries are the vessels that carry the blood away from the heart. An example is the femoral artery, which carries blood to the pelvic limb. Small arteries are called arterioles. Capillaries are very minute vessels, which are extensions of both the arterioles and venules. These minute vessels form a network in the tissues. Veins are vessels that carry the blood back to the heart from the body. They have thin walls and valves to prevent the backflow of blood. An example is the jugular vein, which returns blood from the head to the heart.

2-15. *Lymphatic system.* The lymphatic system contains lymph, lymph vessels, and lymph nodes. Refer to figure 7 as we discuss this system.

2-16. In the lymph system, lymph fluid contains cells and is very similar to blood plasma. It is derived from blood. Lymph carries food to individual body cells and removes their wastes.

2-17. The lymph vessels are superficial vessels that collect lymph from the skin and subcutaneous tissue. There are deep lymph vessels, which collect lymph from deep tissues. An intricate system of lymph vessels can be found in nearly every part of the body except in muscle fibers, nerves, and blood vessels. The flow of lymph through vessels is influenced by differences in pressure, by muscular movements, and by valves that limit flow to one direction.

2-18. Lymph nodes are generally oval shaped and are located along the course of lymph vessels. They are closely checked during meat inspection. Close examination of lymph nodes can reveal tuberculosis and other abscess-forming diseases.

2-19. Respiratory System. The main parts of the respiratory system are the nasal cavity, pharynx, larynx, trachea, bronchi, and lungs. The exchange of carbon dioxide for oxygen takes place in the lungs. The oxygenated blood is returned to the left atrium of the heart for circulation to tissues of the body.

2-20. Urogenital System. This system contains the organs of the urinary tract and the reproductive tract.

2-21. *Urinary tract.* The urinary tract is composed of the kidneys; the ureters, which drain the kidneys; the bladder, which stores the urine; and the urethra, which is the tube through which urine is excreted.

2-22. *Reproductive tract.* In the female, the tract consists of ovaries, fallopian tubes, uterus, and vagina. In the male, the tract consists of the testes, vas deferens, prostate, seminal vesicles, and penis. Adult animals that have not been castrated and animals with undescended testicles impart a strong undesirable odor and taste especially to pork.

Beef Inspection

BECAUSE OF THE enactment of the Wholesome Meat Act in 1967, your job in beef inspection is reduced. This law requires all meat items and facilities used to prepare them to be inspected by the USDA or a State Inspection System that has been declared to be equal to Federal Inspection. Prior to the Wholesome Meat Act, the procurement of red meat from State inspected plants was limited, and additional requirements had to be met by these plants. The enactment of this law has made all meat establishments equal in inspection quality. Hence, the military can consider all plants for procurement on the same criteria. Such procedures as wholesomeness and sanitation inspections performed within the plant are within military requirements for plant approval, although approval is granted on individual plants processing meats for the military.

2. The USDA uses the *Manual of Meat Inspection Procedures* as its guideline in the inspection of meat and meat products. These regulations also specify the sanitary requirements for meat processing establishments. The responsibility for these inspections rests with the Animal and Plant Health Inspection Service of the USDA. However, as a military veterinary inspector, the only time you may expect to assist your base veterinarian in performing an inspection of a red meat plant is overseas, and then we use a *Military Standard* as our directive.

3. All meat processing plants in oversea areas supplying the US Armed Forces must be inspected and approved by the military. MIL-STD 1481, *Sanitary Standards for Meat Processing Plants in Oversea Areas*, establishes the general sanitary requirements for meat processing plants in oversea areas. The veterinarian of each major oversea command is responsible for providing and enforcing sanitation standards for slaughtering establishments and for issuing directives for the reporting of diseased or otherwise unsound carcasses. This provision is necessary to make sure that unfit products are not accepted for military use. To fulfill these responsibilities, the command veterinarian must exercise control over sanitation requirements and antemortem and postmortem inspections. This control is carried out by veterinary personnel who perform or supervise such inspections.

4. As in other areas of food inspection, you in your role as beef inspector are primarily concerned with wholesomeness and quality. To determine these standards, we will concentrate in this chapter on carcass processing and grading, surveillance inspection, and fabricated beef.

3. Beef Processing

3-1. Beef processing, until evisceration (removal of internal organs) is completed, is essentially the same as for pork, lamb, and veal. We shall first explain the processing of beef from the point of evisceration until the carcass is stored in the cooler; then identify classes, styles, and weights; and conclude the section with general inspection requirements.

3-2. From Processing Line to Cooler. After the animal is skinned, it is eviscerated. The organs (viscera) maintain their identity with the carcass from which they were removed. The carcass is then split longitudinally with a large power-driven saw into equal halves (commonly referred to as sides of beef). The operator starts at the posterior end of the carcass and saws through its entire length, splitting the vertebral column. Following this, each side is shrouded.

3-3. *Shrouding*. Shrouding is simply covering the exterior surface of a side of beef with heavy muslin. The cloth is wrung out either in plain, hot, potable water at a temperature of 120° F. to 125° F., or in a 20 percent potable hot salt water (brine) solution at a temperature of about 115° F. These shrouds are held in place by large (about 4 inches long) wooden or metal pins, and remain on the sides of beef until the beef is completely chilled. Chilling time varies with the size of the sides, but usually lasts from 12 to 24 hours. The primary advantages of shrouding are:

a. Reducing meat shrinkage. Normal shrinkage is about 3 percent for unshrouded sides, but for shrouded sides it is approximately 1 to 1½ percent.

b. Reducing external contamination.

c. Molding the external fat.

3-4. *Chilling.* Chilling should be done as rapidly as possible. However, care should be taken that the sides are not subjected to too cold a temperature. Extremely cold temperatures may freeze the exterior surface and prevent adequate rapid chilling of the internal meat. Therefore, a cooler (chill box) temperature of 32° F. to 38° F. is recommended. The product should be chilled to 40° F. or under and should not be frozen. Observing two simple rules will further assure proper chilling: (1) do not permit sides to touch each other, allowing for maximum air circulation and (2) do not permit cooler doors to stand open, causing temperature fluctuation.

3-5. Too little humidity will produce excessive carcass shrinkage and poor cooling. On the other hand, humidity that is too high will cause the carcass to become slimy. The best humidity for beef chill boxes is from 75 to 85 percent. Preserving the quality of a product and maintaining it in a wholesome state should be your concern throughout the entire processing operation. For this reason, the temperature of the holding room(s) is very important. These facilities must be capable of maintaining the constant temperatures required by both chilled and frozen beef.

3-6. *Freezing.* Chilled beef, both carcass and cuts, must be chilled to a temperature of 32° F. to 40° F. Frozen beef is first chilled and then placed in a sharp freezer maintained at a temperature no higher than 0°. Frozen beef for US Armed Forces procurement must not normally be held in a frozen state longer than 180 days.

3-7. Classes, Styles, and Weights. Federal Specification PP-B-221, *Beef, Fresh (Chilled or Frozen)*, is the authority for classes, styles, and weights. It is the authority for our discussion of these aspects of beef processing.

3-8. *Classes.* Beef classes are really little more than sex groups. There are three principal classes with which you are concerned: steer, heifer, and cow. This means that you must be able to determine the sex of a carcass in order to classify it. The classes are more fully defined and described as follows:

a. Steer (class 1) beef is from male bovines that have been castrated before reaching sexual maturity and before developing characteristics typical of bulls and stags.

b. Heifer (class 2) beef is from female bovines that have not attained full sexual maturity.

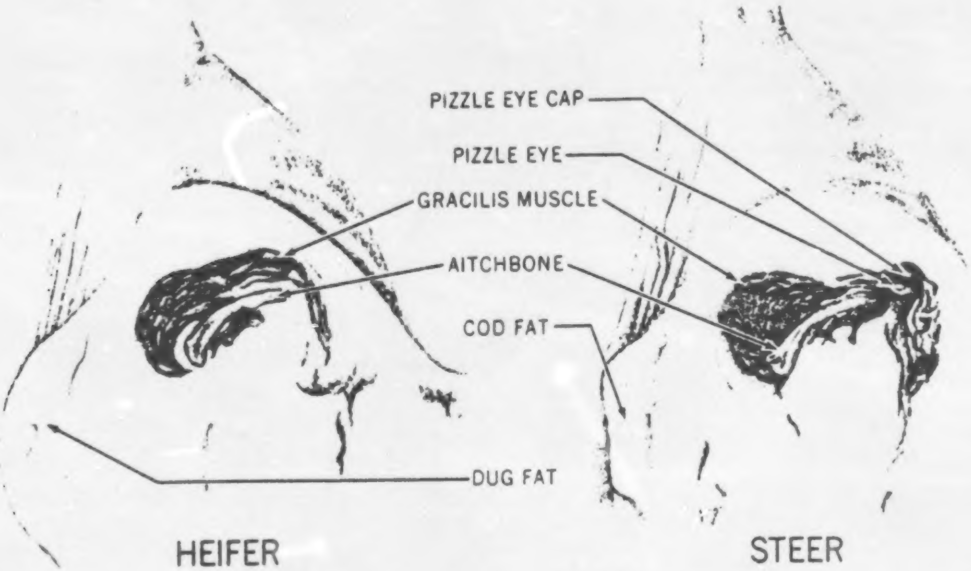


Figure 8. Sex determination factors.

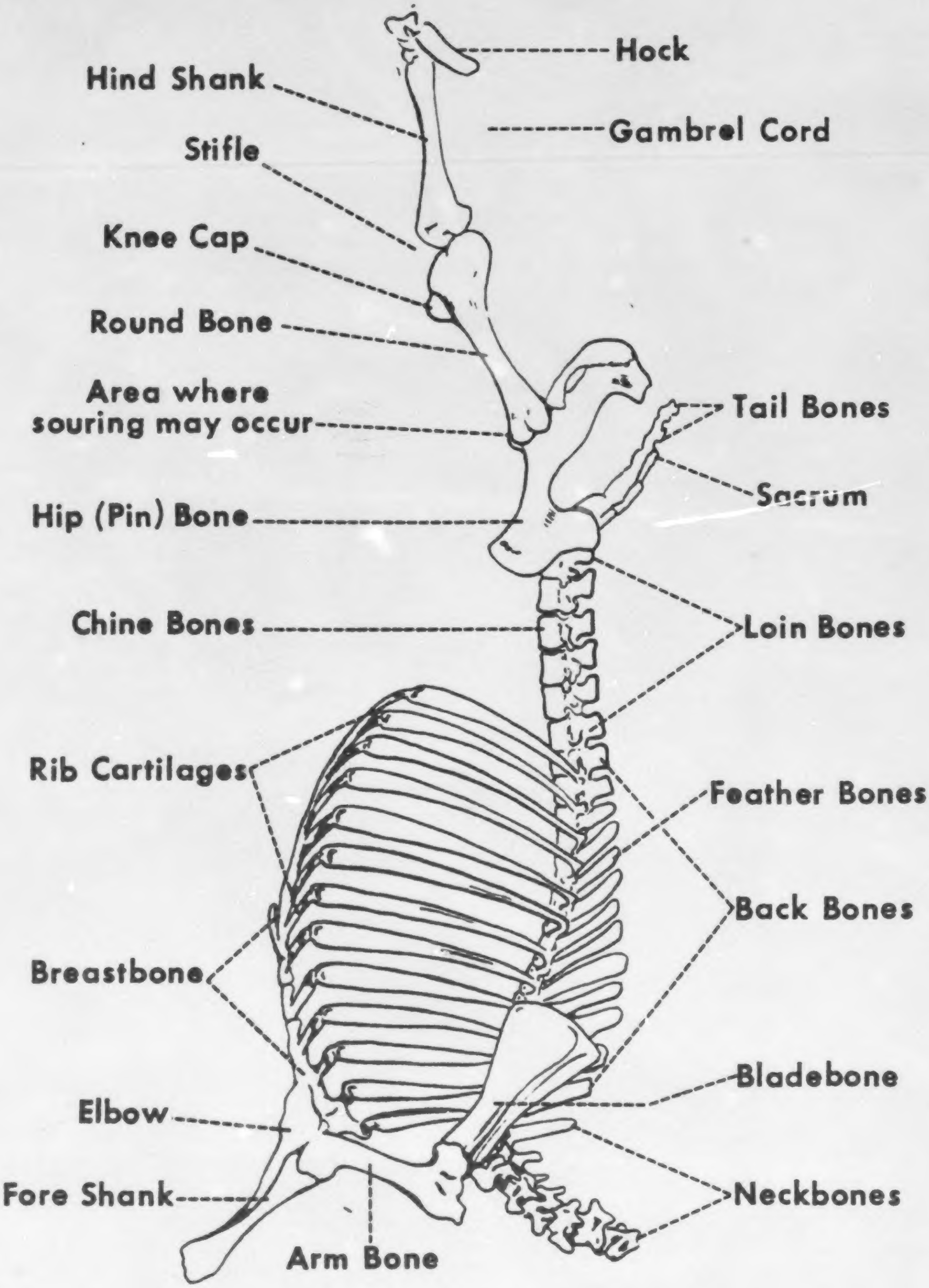

Hock
Hind Shank
Gambrel Cord
Stifle
Knee Cap
Round Bone
Area where souring may occur
Tail Bones
Sacrum
Hip (Pin) Bone
Chine Bones
Loin Bones
Rib Cartilages
Feather Bones
Back Bones
Breastbone
Bladebone
Elbow
Fore Shank
Neckbones
Arm Bone

Figure 9. Beef skeletal chart.

c. *Cow* (class 3) beef is from relatively mature female bovines.

3-9. *Sex determination factors.* For our purposes, there are five anatomical sex determination factors or landmarks. They are the aitchbone, pizzle eye, pizzle eye cap (bald spot), gracilis muscle, and cod and dug fat. Figure 8 depicts these landmarks in the heifer and steer. Refer to this figure as we discuss each of the sex determination factors.

3-10. The *pizzle eye* is the remnant of the base attachment of the penis. It is usually oval in shape and varies from ½ inch to 1¼ inches in size. It is usually larger in bulls than in steers, and is located at the posterior end of the aitchbone, surrounded by the pizzle eye cap.

3-11. The *pizzle eye cap* (bald spot) is the lean meat muscle of the penis surrounding the pizzle eye in the male. There is no visible bald spot in females because the fat has "folded in" and no lean shows at the posterior end of the aitchbone.

3-12. The *gracilis muscle* extends from the cod or mammary fat to the posterior end of the aitchbone. In the female, the exposed portion of this muscle is bean-shaped. In the male, the posterior portion of this muscle is covered by a V-shaped piece of fat.

3-13. We find cod fat in males and dug fat in females. "Cod fat" is the packing house term for the scrotal fat of steers. It is very rough and knobby, and tends to fill the scrotal sac, assuming the shape of the scrotum. There is seldom any evidence of cod fat in bulls; in stags, there is very little, depending on the elapsed time since castration. "Dug fat" is a packing house term for the mammary gland or mammary tissue of cows and heifers. Dug fat is more extensive in heifers than cows, and more smoothly rounded than the cod fat in steers.

3-14. *Styles.* Style refers to the method used to cut up a beef carcass. Figure 9 illustrates the wholesale cuts of a side of beef. Study this figure as we discuss each of the five styles described in Federal Specification PP-B-221. The five beef styles are: Style I, Carcass (quartered); Style II, Side; Style III, Forequarter; Style IV, Hindquarter; and Style V, Wholesale and Fabricated Cuts.

3-15. *Style I, Carcass (quartered)*, is the four matched quarters from a single carcass. The quarters are produced by splitting the carcass down the back into two sides. The sides are separated into forequarters and hindquarters by cutting between the 12th and 13th ribs ("ribbing") as defined in the Official US Standards for Grades of Carcass Beef. The carcass must conform to the following:

a. The skirt (diaphragm), when specified, is removed, but if not removed, the tendinous portion is removed so as to expose lean meat along the entire length of the diaphragm.

b. The thymus gland, mediastinal tissue, and heart fat usually present in the lower thorax (brisket and short plate) are closely removed.

c. Not more than two tail (caudal) vertebrae should remain on the round.

d. An identification number is stamped on each quarter, or a tag having a stenciled or printed number is placed on each quarter to identify each quarter with a specific carcass. For example, all quarters shipped from carcass number 20 are identified by a number 20.

e. Udders from heifer beef are removed (and retained by the supplier) prior to wrapping and shipping. Udders (glandular tissue, open milk ducts, and adjacent fat) are removed in a plane generally parallel to the adjacent ventral abdominal wall so that the fat remaining on the abdominal wall does not exceed 1 inch in thickness. When specified, trimmed carcasses have the kidney knobs, pelvic, and lumbar fat removed from the hindquarter. After trimming, the fat remaining on the applicable thoracic, lumbar,

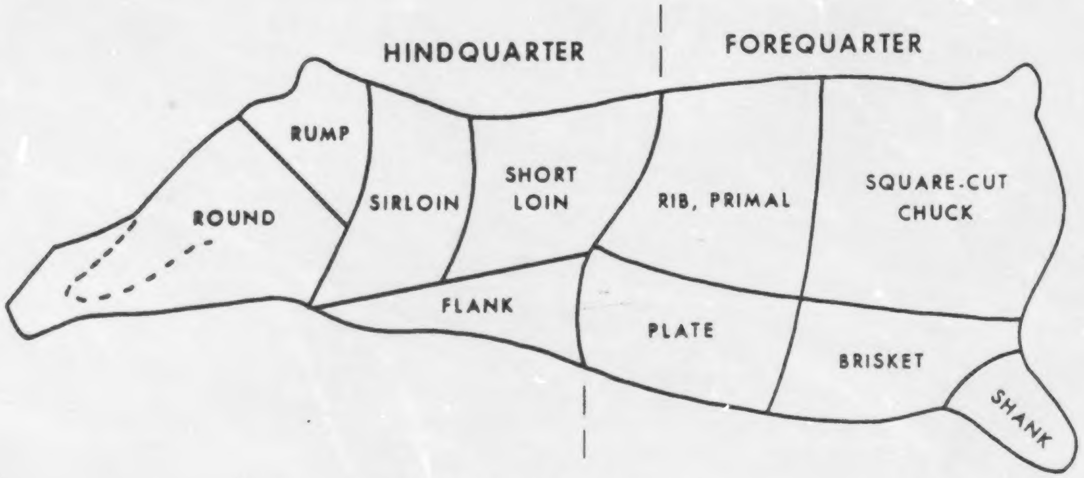


Figure 10. Major wholesale market cuts.

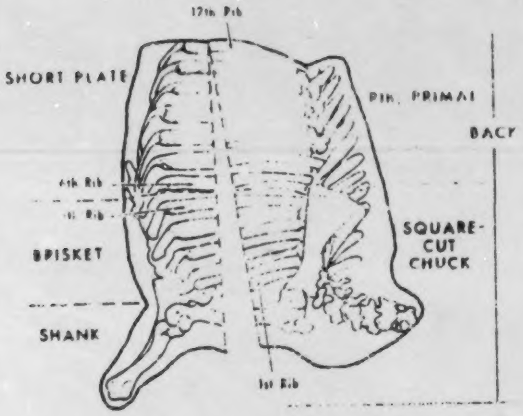


Figure 11. Forequarter.

and pelvic areas should not exceed 1 inch in thickness (measurement to be made to the quarter inch). When specified, the hanging tender is removed so that not more than one-fourth inch of hanging tender tissue remains on the hindquarters.

3-16. *Style II, side* consists of one matched forequarter and hindquarter from one-half the carcass prepared and stamped or tagged as described in Style I above.

3-17. *Style III, forequarter*, is all of the anterior portion of the side remaining after severance between the 12th and 13th ribs. The severance is made and the forequarter is trimmed as specified in Style I above.

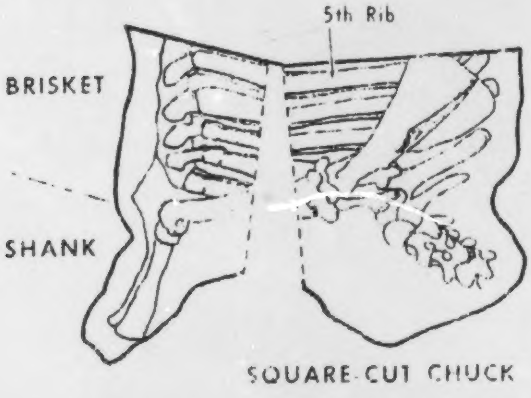


Figure 12. Separation of square-cut chuck from brisket and shank.

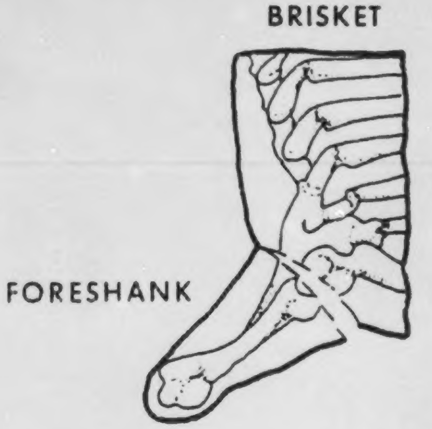


Figure 13. Separation of shank from brisket.

3-18. *Style IV, hindquarter*, is all of the posterior portion of the side remaining after severance between the 12th and 13th ribs. The severance is made and the hindquarter is trimmed as specified for Style I above.

3-19. *Style V, wholesale and fabricated cuts*, must conform to the applicable requirements defined in Federal Specification PP-B-221. Because of the large number of cuts in this class, only the major wholesale market cuts will be discussed. See figure 10. These major cuts are the basis for many of the other cuts of Style V. In many cases these other cuts are nothing more than two or three of the major cuts processed so that they remain in one piece. If you desire further information pertaining to these undiscussed cuts, you may obtain it from the specification.

3-20. The *back* consists of the rib, primal, and the square-cut chuck in one piece. See figure 11.

3-21. The *rib, primal*, is that portion of the forequarter remaining after the removal of the square-cut chuck, shank, brisket, and short plate. See figure 11.

3-22. The *square-cut chuck* is that portion of the forequarter remaining after the removal of the shank, brisket, short plate, and rib, primal. See figure 12.

3-23. The *foreshank* is that portion of the foreleg (shank) remaining intact after the removal of the brisket, short plate, and square-cut chuck from the forequarter. See figure 13.

3-24. The *brisket* is that portion of the forequarter remaining after the removal of the short plate, foreshank, and square-cut chuck (see fig. 13).

3-25. The *short plate* is the ventral portion of the sixth through 12th ribs (see fig. 11).

3-26 The *hindquarter, trimmed*, consists of the round, primal, and the full loin in one piece. See figure 14.

3-27. The *round, primal,* is that portion of the hindquarter remaining after the full loin has been removed (see fig. 14).

3-28. The *loin, full, trimmed,* is that portion of the hindquarter remaining after the removal of the primal round, flank, hanging tender, kidney knob, and excess fat from the lumbar and sacral regions. See figure 15.

3-29. The *short loin, regular,* is the anterior portion of the trimmed full loin. The full loin is cut perpendicular to the lumbar vertebrae and just anterior to the pelvis. See figure 16.

3-30. The *sirloin (loin end)* is the posterior portion of the trimmed full loin. The cut separating the sirloin and the short loin was described in the previous paragraph.

3-31. *Weights.* There are five weight ranges for each style of fresh chilled beef. Because of the wide variation in styles and ranges for each style, this topic will not be discussed further. If more information is desired, refer to Federal Specification PP-B-221.

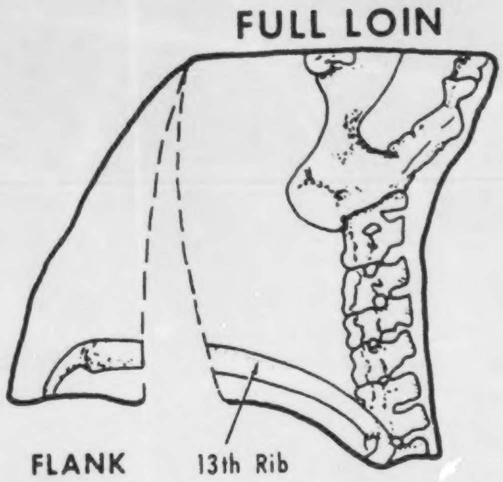


Figure 15. Separation of flank from full loin.

3-32. General Inspection Requirements. When it is procured for military use, fresh beef, chilled or frozen, must be sound, well-dressed, split and quartered beef carcasses, or sound, well-trimmed wholesale market cuts. The beef should be prepared and handled in accordance with good commercial practice and meet the requirements of each respective style, class, grade, state of refrigeration, and specified weight range. You should be alert in your inspection for such requirements, and refuse to accept beef from bulls or stags, and beef cuts that have been excessively trimmed to meet specified

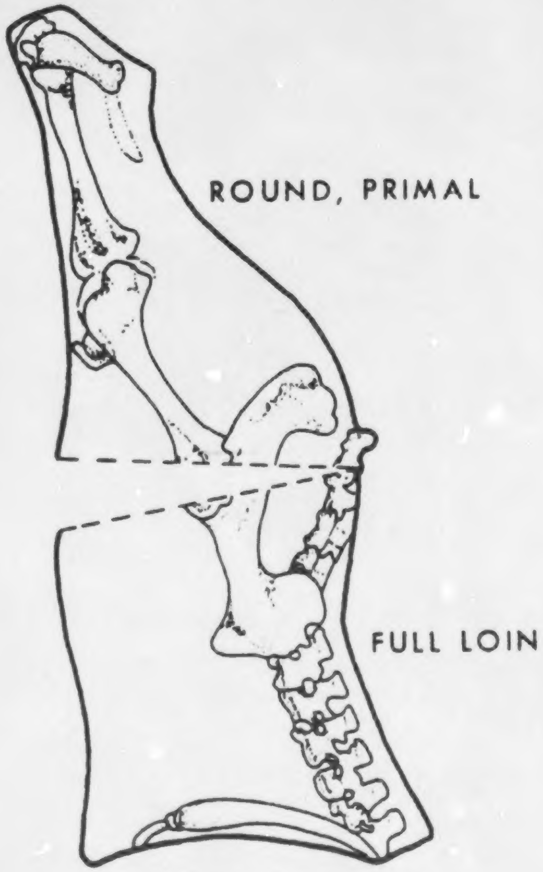


Figure 14. Hindquarter.

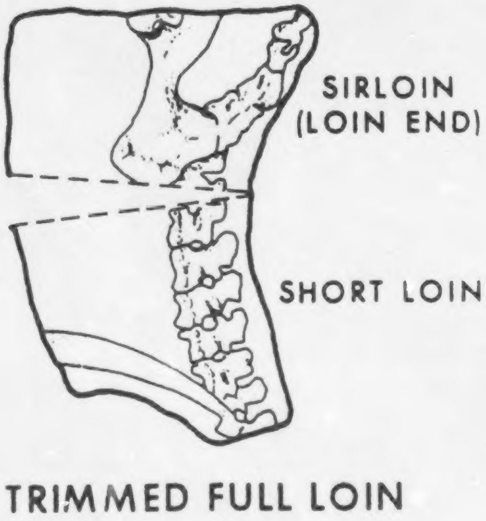


Figure 16. Trimmed full loin.

weights. In fact, beef that is substandard for any reason should be provisionally rejected.

3-33. Beef should also have a good color. It should have no objectionable odors, bruises, blood clots, mutilations, or discoloration. It should be free of detrimental blemishes, ragged edges, superficial appendages, and deep cuts. There should be no evidence of refreezing, freezer burn, mishandling, and other deterioration or damage. In other words, the beef must be in excellent condition. It should possess the quality and other characteristics associated with the style, class, grade, and condition specified in the purchasing instruments when it is delivered to the US Armed Forces. The Federal Government and the contractor are responsible for making the inspection that determines compliance with these requirements.

3-34. The procuring agency of the Federal Government, or a duly authorized representative, makes the inspection at a time and place designated by the procuring agency. It may be at the site of preparation (both during and after preparation), at a suitable point in transit, or after delivery at destination. Unless otherwise specified, the final inspection is normally made at the time of delivery to destination. In the final inspection, it is important that you remember:

a. The approval of any detail of processing or material does not relieve the contractor of responsibility for faulty workmanship or materials, which may be discovered at any time before final acceptance.

b. The contractor should be required to assure that the product conforms to all contract requirements before it is submitted to the US Armed Forces for final acceptance.

c. If the finished product is inspected and passed at a point other than destination, the contractor should request that the product be inspected at destination for condition, count, identity, and temperature.

3-35. As we have already stated, the supplier or contractor is responsible for meeting all the provisions of the specification under which the product was manufactured before he offers the product to the US Government for acceptance. The US Government reserves the right to perform any of the inspections set forth in the specification under which the product was purchased, if such inspections are considered necessary to assure that supplies and services conform to prescribed requirements.

3-36. When beef quarters on contracts specifying destination inspection only are being prepared for shipment by the contractor, there is an additional marking requirement which is not normally required for other styles. The contractor must number each quarter in a way that assures its identification with a specific carcass.

4. Beef Grading

4-1. USDA quality grades are a part of every verification inspection, and the scope and background of beef grading are necessary tools of such inspections. The overall desirability of carcasses and cuts of beef varies over a wide range. At the upper end of the range, the meat has a very appetizing appearance and is extremely pleasant to the taste. The carcasses and cuts that are least desirable have little appeal to either sight or taste. Between these two extremes lie carcasses with varying degrees of desirability. The USDA has developed and established a system for classifying beef into a few definable groups according to its desirability. The USDA describes this system for grading in its publication *Official United States Standards for Grades of Carcass Beef.* This publication has been adopted as an official guide by the US Armed Forces.

4-2. The standards of the grading system are the basis for the development of the different grades. Our objective in this section is to identify the standards for particular grades and the carcass characteristics that you should be able to recognize.

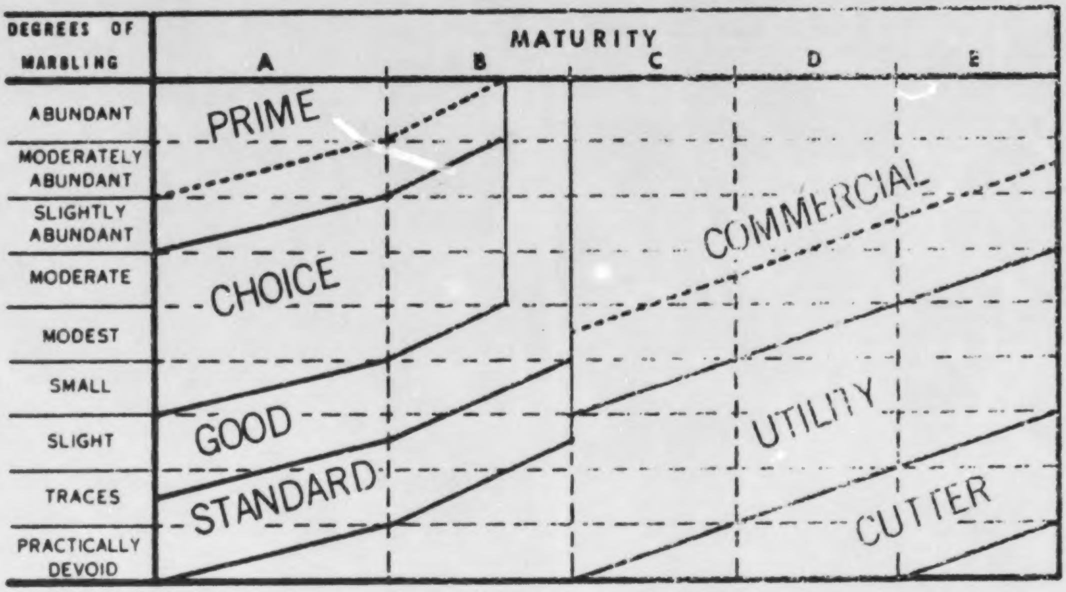
4-3. There are two grading systems used by the USDA in determining the acceptability of a beef carcass. *Quality* grades indicate the tenderness, taste, and appearance of the beef carcass. *Cutability* or *yield* grades indicate the percent of trimmed, boneless, major retail cuts derived from a carcass. Carcass beef may be purchased by specified quality grade, yield grade, or both.

4-4. Quality Grades. USDA quality grades of beef are prime, choice, good, standard, commercial, utility, cutter, and canner. They decrease in quality in the order listed. The lower grades of beef are seldom purchased by the US Armed Forces. Therefore, our discussion will be concerned to a great extent with the better grades. However, if you are ever required to inspect the lower grades of meat, the same principles of grading and evaluation apply.

4-5. Quality grades of beef are determined by a subjective evaluation of certain characteristics of the carcass. These characteristics are separated into

Table 1

Relationship Between Marbling, Maturity, and Quality



conformation factors and *quality* factors. A carcass that has a high-quality grade possesses and displays all of these factors to the highest degree. The absence of, or existence at a lesser degree of, these factors lowers the grade of the carcass.

4-6. Conformation. Conformation is the manner of formation of the carcass or primal cut. The conformation descriptions included in each of the grade specifications refer to the thickness of the carcass and its various parts. The carcasses of primal cuts that have the required thickness of muscling specified for a grade are considered to have a conformation adequate for that grade, despite the fact that, because they lack fat, they do not have the overall degree of thickness and fullness described.

4-7. You should evaluate conformation by taking an average of the conformation of the various parts of the carcass or primal cut. Consider each part with regard to its weight in proportion to the weight of the whole carcass. In addition, compare the general value of each part with the other parts. Although the chuck and round have nearly the same percentage of carcass weight, the round is considered a more valuable cut. Therefore, in evaluating the overall conformation of a carcass, you give the development of the round more consideration than the development of the chuck. Similarly, the conformation of the loin receives much more consideration than the conformation of the rib, because the loin is a more valuable cut and contains a greater percentage of the carcass weight.

4-8. Superior conformation implies a high proportion of meat to bone and a high proportion of the weight of the carcass (or cut) in its more valuable parts. It is reflected in carcasses and cuts that are very thickly muscled, are very full and thick in relation to their lengths, and have a very plump, full, and well-rounded appearance. Inferior conformation implies a low proportion of meat to bone and a low proportion of the weight of the carcass (of cut) in the more valuable parts. Inferior conformation is shown in carcasses and cuts that are very thinly muscled, are very narrow and thin in relation to length, and have a very angular, thin, sunken appearance.

4-9. Quality Factors. Although conformation should never be taken lightly, it is true that quality does take precedence when you are determining the overall grade of a carcass. While the conformation of a carcass controls the amount of lean meat available, the quality factors give the carcass its pleasing appearance, taste, and tenderness, which are of utmost importance in food products. The factors evaluated in determining quality include age, as determined by bone character; and marbling, texture, and color, as indicated by the ribeye muscle.

4-10. *Maturity*. The maturity of the

carcass is determined by the size, shape, and ossification of the bones and cartilages—especially the split chine bones. In the split chine bones, ossification changes occur at an early stage of maturity in the posterior portion of the vertebral column (sacral vertebrae) and at progressively later stages of maturity in the lumbar and thoracic vertebrae.

4-11. *Marbling.* Marbling is the intramuscular fat found within a beef carcass. It is the source of much of the juiciness of a cooked piece of beef. The degree of marbling is determined by observing the exposed ribeye (eye of the beef) after the carcass has been ribbed. The relationship between maturity, marbling, and the quality grade is shown in table 1. The table indicates that as maturity increases from A to E, the degree of marbling must be higher to award a high-quality grade. It should be noted that those animals from C to E are not eligible for the top four quality grades, regardless of the degree of marbling.

4-12. *Texture.* Texture is the term used to describe the size of the muscle bundles of the beef carcass. It is usually determined by an evaluation of the ribeye after the carcass has been ribbed. A finer texture or smaller muscle bundle usually indicates a more tender carcass.

4-13. *Color.* The color of the lean tissue does not indicate the overall quality of a beef carcass as much as the previous three factors do; however, consumer acceptability depends to a large extent upon the esthetically pleasing color of the beef. Most consumers have come to expect a bright, cherry-red color to their beef, and any deviation from this results in a lowering of the grade.

4-14. Quality Divisions. Beef quality grades pertain to three classes of beef. These classes are based strictly on the characteristics of the beef for a particular grade:

- Section 1—steers, heifers, and cows.
- Section 2—bulls.
- Section 3—stags.

4-15. *Section 1 beef.* Steer, heifer, and cow beef (section 1) is further designated as any of eight grades, as shown in table 2. These grades are prime, choice, good, standard, commercial, utility, cutter, and canner. In sections 2 and 3 (bulls and stags), there are only six subgroups. These are choice, good, commercial, utility, cutter, and canner, which are also given in table 2.

4-16. After a carcass is given a section designation, grading within sections is based strictly on the characteristics of the meat and bone. Although beef in all grades is produced and processed, only the better grades are usually procured for the use of the US Armed Forces. For this reason, you should become thoroughly acquainted with the characteristics of prime, choice, and good grade beef.

4-17. Most of the beef procured for military personnel is in section 1. A condensed description of the conformation and quality requirements for all grades is given in table 3. Refer to this table and note the differences in characteristics between grades. Even though the characteristics for each grade are definite, it will be easier for

Table 2

Market Classes and Grades for Dressed Beef

Section I	*Grade*	*Sections II & III*	*Grade*
Steer, heifer and cow*	Prime Choice Good Standard Commercial Utility Cutter Canner	Bull and Stag	Choice Good Commercial Utility Cutter Canner

(*Cow beef is not eligible for Prime Grade.)

Table 3

Beef Palatability Characteristics

Grade	*Conformation*	*Quality*					
		Chine Bone	Thoracic Vertebrae	Sacral Vertebrae	Lumbar Vertebrae	Rib Bones	Ribeye Muscle
Prime	Thickly muscled throughout. Wide and thick in relation to length. (Loins and ribs thick and full. Rounds plump, carrying well down to the hocks. Thick chucks. Necks and shanks tend to be short.)	Slightly red and soft.	Cartilagenous ends show evidence of ossifying (hardening) to partially ossified.	Completely fused.	Cartilagenous ends nearly completely ossified.	Slightly wide and slightly flat.	Light red in color, finely textured, and moderately firm. Minimum degree of marbling required increases with advancing maturity throughout this group from minimum slight abundant to maximum slight abundant.
Choice	Moderately thick muscled throughout. Moderately wide and thick in relation to length. (Loins and ribs moderately thick and full. Rounds and chucks moderately plump and moderately thick. Necks and shanks tend to be moderately short.)	Slightly red and slightly soft.	Cartilagenous ends show evidence of ossification to partially ossified.	Completely fused.	Cartilagenous ends nearly completely ossified.	Slightly wide and slightly flat.	Moderately light red in color, finely textured, and slightly firm. Minimum degrees of marbling required increases with advancing maturity throughout this group from a minimum modest amount to a maximum modest amount.
Good	Slightly thick muscled throughout. At least moderately symmetrical and uniform in contour. (Loins and ribs are slightly thick and full. Rounds tend to be slightly plump. Necks and shanks tend to be slightly long and thin.)	Slightly red and slightly soft.	Cartilagenous ends show evidence of ossification to moderately ossified.	Completely fused.	Cartilagenous ends nearly completely ossified.	Slightly wide and slightly flat.	Slightly light red in color, finely textured, and moderately soft to soft. Minimum degree of marbling required increases with advancing maturity throughout this group from typical traces to a typical slight amount.
Standard	Thinly muscled throughout. Slightly narrow and thin in relation to their length. At least moderately symmetrical and uniform in contour. (Loins and ribs tend to be flat and slightly thin fleshed. Rounds tend to be thin and slightly concave. Chucks tend to be flat and thin fleshed.	Slightly red and slightly soft.	Cartilagenous ends show evidence of ossification to moderate ossification.	Completely fused.	Cartilagenous ends nearly completely ossified.	Slightly wide and slightly flat.	Slightly dark red in color, finely textured, and soft to moderately soft. Minimum degree of marbling required increases with advancing maturity throughout this group from minimum practically devoid to maximum practically devoid.

you to learn to recognize the required degree of conformation and quality for each grade by observing the differences in actual carcasses and cuts.

4-18. *Section 2 beef.* Beef produced from bulls and stags is graded, according to its characteristics, as bull beef and stag beef, in accordance with the standards for bulls and stags. When it is graded and identified according to grade, this beef is identified also for class as "bull" beef or "stag" beef. No grade of bull or stag beef can compare in

Table 3 (cont'd.)

Grade	Conformation	Quality					
		Chine Bone	Thoracic Vertebrae	Sacral Vertebrae	Lumbar Vertebrae	Rib Bones	Ribeye Muscle
Commercial	Slightly thin muscled throughout. Because of usually moderately heavy fat covering, the carcasses tend to be slightly thick but rather rough and irregular in contour. (Rounds tend to be thin and slightly concave. Loins tend to be moderately wide but slightly sunken and hips are rather prominent. Ribs tend to be slightly thin and the plates and briskets are wide and "spready." Necks and shanks are slightly long and thin.)	From moderately hard to hard. From practically white to white in color.	Cartilagenous ends show considerable ossification. The outlines of the cartilages are from barely visible to visible	Completely fused.	Cartilagenous ends nearly completely ossified.	From moderately wide and flat to wide and flat.	From moderately dark red and slightly coarse in texture to dark red and coarse, and from slightly firm to firm. Minimum degree of marbling required increases with advancing maturity throughout this group from a minimum small amount to a maximum small amount.
Utility	Thinly muscled throughout. Very narrow in relation to length. Decidedly rangy and angular in contour. Usually thinly fleshed. (Loins and ribs are flat and thinly fleshed. Rounds tend to be very concave. Chucks are thin and flat. Necks and shanks are long and tapering. Hips and shoulder joints are prominent. Carcasses within the full range of maturity classified as beef are included in this grade.)	Slightly red and slightly soft, to hard and white.	Cartilagenous ends have some evidence of ossification. The outline of the cartilages are barely visible.	Completely fused.	Cartilagenous ends are nearly completely ossified.	Slightly flat to wide and flat.	Slightly dark red and fine in texture. Slightly firm to soft, to the touch, and may be slightly watery. Devoid to maximum small amount of marbling.
Cutter	Thinly muscled throughout. Rangy, angular, and irregular in contour. Very thinly fleshed. (Loins and ribs are very flat, thin and shallow. Necks and shanks are very long and tapering. Hips and shoulder joints are very prominent.) The range in maturity extends to include carcasses from the oldest animals produced for beef.	Slightly red and slightly soft to hard and white.	Cartilagenous ends have some evidence of ossification. The outline of the cartilages are barely visible.	Completely fused.	Cartilagenous ends nearly completely ossified.	Slightly wide and slightly flat, to wide and flat.	Slightly dark red and fine, to very dark red and coarse in texture. Devoid to practically devoid of marbling. Soft and watery, to very soft and watery.

Canner Carcasses that are inferior in conformation and quality to the minimum requirements specified for Cutter Grade are graded Canner.

quality with the same grade of beef from steers, heifers, or cows. Neither is the quality in a designated grade of bull beef comparable with the same designated quality of stag beef.

4-19. Choice bull carcasses have excellent quality, finish, and conformation. Rounds, chucks, and necks are thick and very heavily muscled. Loins and ribs are broad, but tend to be shallow and are relatively small in proportion to the rest of the carcass. The exterior surface is well covered with fat, which, although rough, is not gobby nor excessively deep at any point. Interior fat is plentiful but is somewhat lacking in firmness and brittleness. Usually, such carcasses are derived from young, well-fed bulls, although occasionally carcasses of older bulls meet the requirements of this grade. The flesh generally is of a medium dark-red color, which is firm but comparatively dry.

4-20. As with carcasses in section 1, there is a gradual decrease in quality and conformation through the remaining grades. Canner grade bull carcasses have extremely poor characteristics. Visible finish is generally absent. These carcasses are very thin throughout. The round and chucks are thin, and the loins and ribs are very thin and flat or sunken. There is no exterior or interior fat, and the flesh is soft and dark.

4-21. *Section 3 beef.* Like the carcass in sections 1 and 2, there is a decrease in the quality and conformation from choice grade stag beef (section 3) through the other five grades. Because you are unlikely to work with stag beef carcasses to any extent, we will describe only the characteristics of the choice grade. In cutter grade stag beef, quality and conformation are definitely deficient, and it is seldom even found on the market.

4-22. Choice grade stag carcasses have excellent quality, finish, and conformation. Rounds are thick, full, and bulging. Loins and ribs are moderately thick, and chucks are thick and heavily fleshed. Necks are moderately short and thick. The exterior fat covering of the carcass, although slightly rough, generally extends well over the carcass. Interior fat is plentiful in the crotch and on the breast, and the kidneys, as a rule, are well covered. The flesh is firm and fine grained for the class, and shows some intermixture of fat along the muscle seams. Its color varies from medium to dark red.

4-23. At this point in our discussion, you should have a good knowledge of the recognizable characteristics of carcasses in the various beef palatability grades. There are other principles, which you should learn, that concern the procedures for determining the palatability grade of any beef carcass. You must use these principles when you are performing beef grading and inspection duties.

4-24. Determining Quality Grades. To determine the quality of a beef carcass, it must be properly "ribbed." This is done by cutting the carcass into two sides by splitting it down the back. One side must be partially separated into a hindquarter and forequarter by making a saw cut perpendicular between the 12th and 13th ribs. Any other method of ribbing can prevent an accurate evaluation of the grade-determining characteristics. Therefore, carcasses ribbed by other methods are eligible for grading only if accurate grade determination is possible.

4-25. When you are examining the ribbed carcass, remember that the requirements for marbling increase progressively with evidences of advancing maturity, indicated in the maturity groupings (A through E) of table 1. Notice carefully the relationship of these maturity groups and the nine degrees of marbling. The degree of marbling and other lean characteristics specified for the various grades are based on their appearance in the ribeye muscle, which is exposed by proper ribbing. Although no consideration is given for marbling beyond maximum abundant, superiority in one characteristic of quality (such as marbling) can sometimes compensate for a deficiency of another characteristic.

4-26. *Compensation*. Superiority in the characteristics of the lean is permitted to compensate for a deficiency of conformation. The rate of compensation must be on an equal basis. For example, a given degree of superior quality (above the minimum required for a specified grade) can compensate for the same degree of deficient conformation. In a similar way, superior conformation can compensate for deficient quality in all grades except prime, choice, and commercial. However, the substitution of conformation for quality is limited to a compensation of one-third. The conformation must be at least one-third more than the minimum conformation required for the grade concerned. The one-third limitation for deficient quality is to keep the quality from being too low.

4-27. *Compliance*. When you are determining compliance with the maximum maturity limits for prime, choice, good, and standard grades, consider the color and texture of the lean only when the other maturity-indicating factors indicate just a slightly more advanced degree of maturity than is specified as maximum for the applicable grade. The same principle, in reverse, applies to determining compliance with the minimum maturity limits of commercial grade.

4-28. You should realize by now that the final grading of a carcass or primal (wholesale) cut is based on a composite evaluation of its conformation and quality. Since relatively few carcasses or cuts have identical development of conformation and quality, it is obvious that each grade includes various combinations of the development of these two characteristics. You will find that many carcasses or wholesale cuts which qualify for a particular grade have some characteristics that are more typical of another grade. For example, a carcass that has choice *quality* may have *conformation* of good and still remain eligible for the choice grade. You must also realize that some of the wholesale cuts produced from a carcass may not be of the same grade as the carcass. When this occurs, the grade of the wholesale cut(s), not the carcass, has precedence. Your full understanding of the grading of carcasses for quality can only be reached with actual experience in grading. The principles and characteristics presented in this section, however, represent the basic information you will need for such work.

4-29. Cutability Grades. A beef carcass consists of lean flesh, fat, and bone. The lean flesh furnishes the edible portions to a very great extent. Certainly, marbling of the lean with streaks of fat is highly desirable, and a certain amount of other fat is also palatable and acceptable. But large deposits of external and internal fat on a carcass are not desired and must be trimmed away. Bone, although a functional necessity to the animal, is surely not edible and must be considered as waste. Therefore, only a part of a carcass is both edible and palatable. As we previously mentioned, this part can be described as a percentage or ratio of the whole carcass and is referred to as the "cutability" of the carcass. This ratio is determined by four objective evaluations of measurable data from the carcass which are placed into the USDA cutability formula.

4-30. *Evaluation factors.* A carcass with good conformation is expected to yield a high percentage of trimmed, boneless beef, but this is not always true. For this reason, a separate evaluation of a carcass is made to determine its cutability (or yield). There are five cutability or yield grades (1 through 5). These grades are determined by four variable factors. They are: the thickness of external fat (to the nearest tenth of an inch); the percent of kidney, pelvic, and heart fat; the hot carcass weight; and the cross-sectional area of the ribeye muscle (expressed in square inches). A high yielding carcass will have a cutability grade of 1 or 2 and will exhibit a minimum amount of external kidney, pelvic, and heart fat and a large cross-sectional ribeye.

4-31. The amount of external fat on a carcass is evaluated in terms of the thickness of the fat over the ribeye muscle. The ribeye fat is measured perpendicular to the outside surface at a point three-fourths of the length of the ribeye from its chine bone. This measurement can be adjusted, as necessary, to reflect unusual amounts of fat on the other parts of the carcass. Four-tenths of an inch of variation in fat thickness over the ribeye makes a full yield grade change.

4-32. The percent of kidney, pelvic, and heart fat considered in determining the cutability grade includes the kidney knob (kidney and surrounding fat), the lumbar and pelvic fat in the loin and round, and the heart fat in the chuck and brisket area. This fat is removed when closely trimmed retail cuts are made. The amount of this fat is evaluated subjectively and expressed as a percentage of the carcass weight. A change of 5 percent in these amounts makes a full yield grade change.

4-33. Hot carcass weight is used in determining the cutability grade. The percentage of retail cuts will decrease as the carcass weight increases. An increase of 250 pounds will lower the cutability grade by one full grade.

4-34. The area of the ribeye is determined at the point where this muscle is exposed by ribbing. It is usually estimated subjectively, although it may be measured. An increase in the area of ribeye proportionally increases the amount of retail cuts. A difference of 3 square inches in ribeye area changes the grade by one full cutability grade.

4-35. *Cutability grade formula.* The overall cutability grade is determined by a combination of the four carcass considerations mentioned. The USDA *Official Standards for Grades of Carcass Beef* furnishes a mathematical formula to determine the cutability grade. The formula uses five constants (numbers that never vary), four of which are coupled with variable factors representing the four considerations that we have just discussed. The remaining constant is used along. The result of the computation is the grade designation.

4-36. When you are determining the

cutability grade of a carcass, you must first make an evaluation of each of the four grade variables. If unusual conditions exist, you may need to adjust the estimate or measurement of one or more of these variables. After you have determined the numerical value of the variables and have adjusted them as necessary, you are ready to substitute them in the mathematical equation for cutability grades.

4-37. If the thickness of the external fat must be adjusted, pay particular attention to the amount of fat in such areas as the brisket, plate, flank, cod or udder, inside round, rump, and hips in relation to the actual fat thickness over the ribeye. If a carcass is fatter over other areas than over the ribeye, adjust the measurement upward. If a carcass has less fat over other areas, adjust the measurement downward. In many carcasses, no adjustment is necessary, but an adjustment of one-, two-, or three-tenths of an inch is not uncommon, or an even greater adjustment may be necessary. The measurement of external fat is made in inches or fractions of an inch (usually in tenths).

4-38. You must use the hot carcass weight in determining the cutability grade. If you must use the chilled carcass weight to determine the hot carcass weight, you must compensate for the shrinkage that occurs during chilling. To do this, multiply the chilled carcass weight by 102 percent.

4-39. You must measure, or closely estimate, the area of the ribeye. Express the measurement in square inches (and fractions in tenths). This measurement is made with a grid calibrated in tenths of square inches, or with other devices designated by the USDA.

4-40. The formula for determining the cutability grade takes the following form:

$$\text{Cutability grade} = 2.50 + 2.50T + 0.20P + 0.0038W - 0.32A$$

where:

T = Thickness of external fat (in tenths of inches)
P = Amount of kidney, pelvic, and heart fat (in percent of carcass)
W = Hot carcass weight (in pounds)
A = Cross-sectional area of ribeye (in square inches)

When you are solving this equation, the cutability grade is expressed by the whole number in the answer. (Any fractional part to the right of the decimal of the answer is dropped.) For example, if the computation results in an answer of 3.9, the cutability grade is 3.

4-41. With this explanation of the formula, we will compute the cutability grade of a sample carcass. Assume that the carcass, which weighs 500 pounds before chilling, has 0.2 inch of adjusted external fat. Also assume that the kidney, pelvic, and heart fat makes up 2 percent of the carcass weight and that the area of the ribeye is 11.5 square inches. We will find the cutability grade step by step, as follows:

Step 1. The constant, which is not coupled with a variable representing a cutability characteristic, is set down for computation:	2.50
Step 2. The second constant is multiplied by the adjusted external fat thickness (2.50 × 0.2 = 0.50), and the result is placed under the constant of Step 1 in a column:	2.50 + .50
Step 3. The third constant is multiplied by the percent of kidney, pelvic, and heart fat (0.20 × 2 = 0.40), and the result is placed in the column:	2.50 .50 .40
Step 4. The fourth constant is multiplied by the hot carcass weight (0.0038 × 500 = 1.90), and the result is placed in the column and the sum is computed:	2.50 .50 .40 1.90 5.30
Step 5. The fifth constant is multiplied by the area of ribeye (0.32 × 11.5 = 3.68), and the result is placed in the column under the sum of the results through Step 4. The difference is taken and the fraction to the right of decimal part is canceled out or dropped:	5.30 - 3.68 1.62

Therefore, this carcass is cutability grade 1. You can use this method to determine the cutability of any carcass.

4-42. The same formula is used to determine the cutability grade of forequarters, hindquarters, ribs, loins full-trimmed, and short loins trimmed. However, before applying the formula to these cuts, you must first determine the hot carcass weight of the carcass from which they are produced. This is done by multiplying the chilled weight of the cut by an established constant. The constants for the various cuts are as follows:

Forequarter	3.90
Hindquarter	4.25
Rib	22.75
Loin, full-trimmed	12.75
Short loin, trimmed	29.10

For example, you can assume that a

forequarter weighing 150 pounds after chilling has been cut from a carcass whose hot carcass weight was 585 (150 X 3.9) pounds. If the chilled weight of ribs is 32 pounds, the hot carcass weight can be computed to be 728 (32 X 22.75 pounds.

4-43. In addition, when you are determining the cutability grade for trimmed forequarters, trimmed forequarter cuts, trimmed hindquarters, and trimmed hindquarter cuts, standard percentages for kidney, pelvic, and heart fat are used. They vary with the quality grade of the quarter or cut concerned and are as follows:

Grade	*Percent of Kidney, Pelvic, and Heart Fat*
Prime	4.5
Choice	3.5
Good	3.0
Standard	2.0
Commercial	4.0
Utility	2.0
Cutter and Canner	1.5

4-44. You now have the principles you need for determining the cutability grade of carcasses and cuts. You have been given the constants that you must use and have learned how to use them in the formula. Take one more step now to make sure that you understand, and that you can put your knowledge to work. Here are a few problems for you to solve. After you make your computations, check your answers and procedures against the correct solutions, which follow the problems.

4-45. Problem Situation Number 1: The following carcasses are USDA Prime. Calculate the cutability grade for each:

Carcass #1

Thickness of external fat	1.0 inch
Kidney, pelvic, and heart fat	4.5 percent
Hot carcass weight	500.0 pounds
Area of ribeye	9.0 square inches
Cutability grade	= __________

Carcass #2

Thickness of external fat	0.3 inch
Kidney, pelvic, and heart fat	2.5 percent
Hot carcass weight	500.0 pounds
Area of ribeye	11.5 square inches
Cutability grade	= __________

Carcass #3

Thickness of external fat	0.4 inch
Kidney, pelvic, and heart fat	2.5 percent
Hot carcass weight	800.0 pounds
Area of ribeye	16.0 square inches
Cutability grade	= __________

Carcass #4

Thickness of external fat	1.1 inches
Kidney, pelvic, and heart fat	5.0 percent
Hot carcass weight	800.0 pounds
Area of ribeye	13.5 square inches
Cutability grade	= __________

4-46. Problem Situation Number 2: Compute the cutability grade of the following trimmed beef quarters:

Trimmed Quarter #1

Forequarter	
USDA Choice Grade	
Thickness of external fat	0.9 inch
Chilled weight	143.0 pounds
Area of ribeye	8.8 square inches
Cutability grade	= __________

Trimmed Quarter #2

Hindquarter	
USDA Choice Grade	
Thickness of external fat	0.4 inch
Chilled weight	204.0 pounds
Area of ribeye	16.3 square inches
Cutability grade	= __________

4-47. Solutions to Problem Situation Number 1:

Carcass #1

2.50		(Constant)
2.50	(2.50 × 1.0)	(T)
.90	(.20 × 4.5)	(P)
1.90	(.0038 × 500)	(W)
7.80		
−2.88	(.32 × 9.0)	(A)
4.92		

Cutability grade = 4

Carcass #2

2.50		(Constant)
.75	(2.50 × .3)	(T)
.50	(.2 × 2.5)	(P)
1.90	(.0038 × 500)	(W)
5.65		
−3.68	(.32 × 11.5)	(A)
1.97		

Cutability grade = 1

Carcass #3

2.50		(Constant)
1.00	(2.50 × .4)	(T)
.50	(.20 × 2.5)	(P)
3.04	(.0038 × 800)	(W)
7.04		
−5.12	(32 × 16.0)	(A)
1.92		

Cutability grade = 1

Carcass #4

2.50		(Constant)
2.75	(2.50 × 1.1)	(T)
1.00	(.2 × 5)	(P)
3.04	(.0038 × 800)	(W)
9.29		
−4.32	(.32 × 13.5)	(A)
4.97		

Cutability grade = 4

4-48. Solution to Problem Situation Number 2:

Trimmed Quarter #1

2.50		(Constant)
2.25	(2.50 × .9)	(T)
.70	(.20 × 3.5)	(P)
2.11	(.0038 × 3.9 × 143)	(W)
7.56		
−2.81	(.32 × 8.8)	(A)
4.75		

Cutability grade = 4

Trimmed Quarter #2

2.50		(Constant)
1.00	(2.5 × .4)	(T)
.70	(.2 × 3.5)	(P)
3.28	(.0038 × 4.25 × 204)	(W)
7.48		
−5.21	(.32 × 16.3)	(A)
2.27		

Cutability grade = 2

4-49. You should now understand the principles of beef grading and be able to recognize the characteristics of carcasses and wholesale cuts of the various cutability grades. Further, you should know how to determine the cutability grade of a particular carcass or wholesale cut by estimating or measuring the four variable characteristics that may change the grade. In the discussion of surveillance inspections that follows, you should realize the application of such requirements as specification terminology and USDA grading systems in the verification of carcass beef.

5. Surveillance Inspection

5-1. Surveillance inspection, for our purposes, refers mainly to beef carcasses, sides, and quarters. This inspection is performed just before the product is shipped and immediately after it arrives at its destination. Surveillance inspection is also performed on beef in storage. This kind of inspection is not necessarily limited to the information that we will discuss in this section. However, your procedures should include the inspection points and conditions that we will explain. You must apply, in addition, any other standards that are necessary to determine contract compliance and wholesomeness of the product.

5-2. When you are inspecting for contract compliance, you should have a copy of the contract in hand. Be thoroughly familiar with that document and all the related publications it cites, such as articles, clauses, and specifications. Your inspection of the product should include an examination of grade, weight, temperature, and markings. Also, check the cleanliness and temperature of the vehicle used to transport the product, as well as the cleanliness and temperature of the beef holding or storage rooms. When inspecting the product for wholesomeness and soundness, you should be alert for the presence of slime, mold, and "off" odors.

5-3. Condition Defects and Deterioration. The purpose of inspection at destination is to verify the product as being sound or in excellent condition and in compliance with the contract. An understanding of major carcass defects and areas of deterioration is necessary to assuring a product that is wholesome for issue and of quality equal to the price paid by the Government.

5-4. *Skirt.* Restricted air circulation under the skirt causes it to become slimy to the touch. The skirt is the part of the diaphragm remaining on the forequarter of the carcass after it has been dressed.

5-5. *Hanging tender.* The hanging tender is another area you should inspect for slime. It tends to deteriorate rapidly because of the amount of exposed muscle tissue, and because of blood and serum drippings from other parts of the carcass. The hanging tender is the muscular pillars of the diaphragm found in the hindquarter.

5-6. *Jugular furrow.* The pathway of the large blood vessels in the neck is another area. The vein that is stuck in bleeding the animal during slaughter is located in the jugular furrow. Blood seepage and serum in this area promotes the growth of spoilage-causing bacteria. The presence of off odor is a good indicator.

5-7. *Exposed cut muscle surfaces.* These tend to spoil or deteriorate faster than surfaces covered with fat. Sliming, dehydration, and bacterial decomposition occur in these areas earlier than in other parts of the carcass. First examine the gracilis muscle (dorsal to the aitchbone) for this condition and then the eye muscles.

5-8. *Bruises.* Superficial bruises on the surface of the product are of minor significance. However, those that penetrate into the meat could be cause for rejection.

5-9. *Sour round.* Sour round (bone taint), as indicated by its name, is located in the round. It can usually be traced to the ball-and-socket joint. You can detect sour round by smelling a meat trier immediately after it has been removed from the ball-and-socket joint. If the sour condition is present, you will detect a noxious odor. This condition results from improperly chilling the product, allowing bacteria to grow, and from the production of propionic acid (odor causative). Improper chilling is due to poor spacing of the carcasses in the chill room, poor ventilation or air circulation, poor cooling apparatus, and heavy (meaty) carcasses.

5-10. Carcasses with sour round should be recommended for rejection. If this condition is detected after final acceptance, the procurement agency concerned should be notified so that possible recovery action involving latent defects can be taken. Latent defects are those that are not detectable by normal inspection. If the beef is Government-owned and is to be retained, the rounds should be split to the bone so that you can examine the surrounding tissue for a grayish discoloration. If the grayish discoloration is present, it should be trimmed away and discarded, and the remainder of the hindquarter should be allowed to air out in a chill room. If no discoloration is present, airing the product in a chill room overnight will probably destroy the off odor and off flavor associated with sour round and the meat can be used for its intended purpose.

5-11. *Eye of beef.* The eye of beef was explained when we discussed grading. It is significant here in regard to soundness and wholesomeness. The eye of beef can be observed either on the hindquarter (loin end) or the forequarter (rib end). The following off conditions (sometimes latent defects) are of particular significance in the eye muscle:

a. Dark cutter—this is a condition in which the lean tissue is very dark in color and usually soft, sticky, and gummy to the touch. This condition is not a health hazard but is considered to be a reduction in quality and therefore rejectable. USDA meat graders usually downgrade such carcasses one grade.

b. Two-toned—two definite shades of red exist in the eye muscle. The condition is not hazardous but should be considered as below quality and therefore rejectable.

c. Spotters—evidence of this condition is hemorrhage areas (spots) of varying size throughout the eye muscle. It is not hazardous but should be considered for rejection because of reduction in quality.

d. Sore or scar—this appears as a small off-white water spot (cystlike sore) in the eye muscle. This condition represents a reduction in quality; therefore, rejection should be recommended.

e. Abscesses—these appear as pockets of pusslike material of varying size, scattered throughout the eye and possibly other parts of the carcass. Rejection should be recommended on the grounds of unwholesomeness and reduced quality.

5-12. The above-mentioned conditions are excellent examples of unwholesomeness and/or reduced quality as they appear in carcass beef. If these conditions (defects) are discovered after Government acceptance and/or the expiration of the warranty period, *do not* recommend destruction as unfit for human consumption unless it is obvious that the entire carcass is affected. Recommend that the portions of the carcass (such as the eye muscle) be thoroughly trimmed out and the remainder be used for its intended purpose.

5-13. **Vehicle and Product Temperature.** One of the first steps performed at destination is the taking and recording of vehicle and product temperature. The temperature of the vehicle is often not applicable, but the internal temperature of the product is very important. Product internal temperature should be no higher than 40° F. for chilled beef and 0° F. for frozen beef. It is important to maintain this temperature; therefore, keep the vehicle secured until offloading is begun.

5-14. Inspect the vehicle in which the product is transported for overall cleanliness and off odors. The ceiling, walls, and floors should be clean. If floor pallets are used, raise them and inspect the floor of the vehicle. Do not assume that the floor is clean. Doors should close tightly to prevent dust and other outside foreign material from contaminating the product and to assure adequate temperature control.

5-15. Except where we have pointed out specific differences, surveillance inspection is basically the same at the contractor's establishment and at destination. It is important for you to realize that the inspection may be performed at either or both places. For example, the weight of the product is checked at the contractor's establishment before shipment and after arrival at destination. When you are performing surveillance inspection of beef in

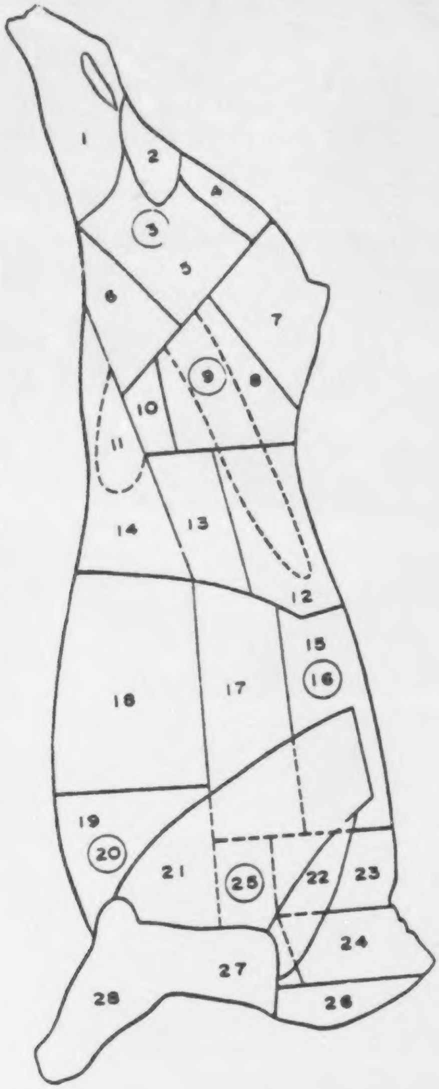


Figure 17. Location of boneless beef cuts.

storage, you should be primarily concerned with the product's condition and temperature. Also, consider holding-room temperature, sanitation, and storage techniques. If the product shows signs of deterioration, recommend the appropriate disposition. For example, trimming spoiled areas in the carcass may be indicated, or immediate issue and consumption may prevent a complete loss of certain carcasses. Before leaving this subject—a word of caution. When you find an off condition in stored beef, consult with your supervisor before making any recommendations as to its disposition unless you are absolutely certain you are correctly evaluating the product.

6. Beef Roasts and Steaks, Boneless, Frozen

6-1. In an attempt to eliminate the waste of carcass beef, a product known as fabricated beef has been introduced and improved to the point of replacing carcass beef in troop issue subsistence. Fabricated beef was first introduced to the US military during World War I. It was during this period that the foreshank and hindshank were removed, primarily for easier handling and to conserve space. Later the beef industry began boning out complete carcasses, and the end product was known as no-bone beef. We now have a product of this type which is known as *Beef Roasts and Steaks, Boneless, Frozen*, commonly referred to as "fab beef." The specification which governs the production and inspection of fab beef is MIL-B-43813, which will be discussed in terms of classification of boneless cuts, processing requirements, the production of ground and diced beef, and requirements of inspection.

6-2. Classification of Boneless Beef. Fab Beef is identified by type and style. Type refers to the general category or use of the cut. This includes oven roasts, pot roasts, grill steaks, tenderloin steaks, swiss steaks, and minute steaks. Style refers to the individual cuts found within a certain type.

6-3. Because of the length and complexity of the specification governing fab beef, only major points pertaining to the production and inspection of the product will be discussed. It should also be pointed out that MIL-B-43813 is a new specification. Because of this, several changes should be expected as the weaknesses of the document become known. It is suggested that you refer to the specification as you read this section to make sure that the material is still valid.

6-4. *Type I, oven roasts.* Oven roasts are cuts from the carcass which are of sufficient tenderness and contain enough intramuscular fat to allow the cut to be cooked with dry heat. All of the oven roasts are obtained from the hindquarter. The cuts of meat that are categorized as oven roast and some of the major requirements for each are as follows:

a. The *knuckle* (style 1) is the meat just anterior to the stifle joint. Figure 17, number 6, shows the location of the knuckle. If the cut weighs more than 10 pounds, it must be divided into equal halves by a slice parallel with the long axis of the cut of meat.

b. The *inside round* (style 2) is obtained from the medial portion of the hind leg. It is number 3 in figure 17. You will note that the inside round lies underneath number 5, the outside round. Each whole inside round must be divided into equal halves by a slice parallel to the long axis.

c. The *eye of round* (style 3) is only one muscle, the semitendinosus. Figure 17, number 4, shows that it is located at the extreme posterior part of the round.

d. The *outside round* (style 4)is located on the lateral side of the round and is number 5 in figure 17. It must be divided into equal halves by a slice parallel with the long axis of the cut. It must also be mechanically tenderized. The method by which this is done will be discussed later.

6-5. *Type II, pot roasts.* Pot roasts are cuts from the carcass which are not as tender or do not have as much intramuscular fat as do type I, oven roasts. For this reason, the cuts must be cooked with moist heat. This means that water or gravy must be added during the cooking process. All of the pot roasts are obtained from the forequarter. The cuts of meat that are categorized as pot roasts and some of the major requirements for each are as follows:

a. The *chuck roll, blade end* (style 1), is obtained from the anterior portion of the neck. Figure 17 shows the chuck roll, neckend, as number 24. The backstrap must be removed from the cut.

b. The *shoulder clod* (style 2) is located just posterior to the midpoint of the scapula. It is number 21 in figure 17. It must be divided lengthwise through the center into equal halves and be free from tears which exceed 3 inches in any dimension.

c. The *chuck roll, neckend* (style 3), is located posterior to the chuck roll, neckend and medial to the shoulder blade. It is number 23 in figure 17. The backstrap must be removed from this cut of meat.

6-6. *Type III, grill steaks (regular).* Grill steaks are the cuts from a carcass which possess enough marbling and sufficient tenderness so that artificial tenderization is not required before frying or broiling the meat. Because of their high-quality and palatability, grill steaks are one of the most expensive categories of fab beef.

6-7. Because all grill steaks are very similar in nature, many requirements pertain to all styles. All grill steaks must be sliced at right angles to the grain of the meat. Each steak must weigh between 6½ and 7½ ounces. No steak may be less than one-half inch in thickness, and they cannot be butterflied. The cuts of meat which compose the grill steak category and some of the requirements peculiar to each cut are as follows:

a. The *ribeye* (style 1) is that portion of the longissimus dorsi muscle (eye of the beef) which is located on the forequarter. It is cut from the sixth to 12th primal rib. See number 16, figure 17. The ribeye cover, which is the fat and thin muscle that covers the actual ribeye, must be removed. The backstrap must also be removed.

b. The *top sirloin butt* (style 2) is removed from the sirloin region of the carcass. See number 8, figure 17.

c. The *loin strip* is that portion of the longissimus dorsi muscle which is located between the 13th rib and the fifth lumbar vertebrae of the hindquarter. See number 12, figure 17.

6-8. *Type IIIA, grill steaks (formed).* The same cuts of meat that were used for type III are used for type IIIA. The only difference between the two is that type III steaks maintain their natural shape, whereas type IIIA steaks are molded into a uniform shape. Each style of grill steak has a particular mold shape. The shaping of each steak is accomplished by first freezing the unsliced boned cut to approximately 0° F. and then tempering it to a temperature of not less than 24° F. and not greater than 28° F. The cut is then pressed (formed) into the shape of that particular style and sliced.

6-9. *Type IV, tenderloin steaks (regular).* Type IV steaks are obtained from the tenderloin muscles (psoas major and psoas minor) of the carcass. The tenderloin is located ventral to the lumbar vertebra in the hindquarter. See number 9, figure 17. The tenderloin is the most tender and consequently the most expensive cut of meat on the beef carcass. When preparing the tenderloin for type IV steaks, the anterior end (thin end) of the muscle and the major blood vessel that lies dorsal to it (dorsal aorta) are removed.

6-10. *Type IVA, tenderloin steaks (formed).* As was in the case of the grilled steak category, the only difference between type IV and type IVA is that the latter is frozen, tempered, molded, and sliced. Type IV maintains the natural shape of the cut.

6-11. *Type V, swiss steaks (regular).* Swiss steaks are derived from the same cuts that compose the oven roast (type I). The difference between the two is that whereas the knuckle, inside round, eye of the round, and outside round are purchased in the whole or unsliced form for oven roasts, they are sliced to a thickness of not less than ⅞ inch nor more than 1 inch for swiss steak.

6-12. Swiss steak cuts are not mechanically tenderized or butterflied. They must be cut at right angles to the grain of the meat and must weigh from 5½ to 6½ ounces. The length of each steak cannot exceed the width by more than 1½ inches.

6-13. *Type VA, swiss steaks (formed).* As was the case in type III and type IV, the only difference between type V and type VA is that type V retains the identity of the beef cut from which it was obtained, while type VA cuts have been frozen, tempered, and molded prior to slicing.

6-14. *Type VI, minute steaks (regular).* Minute steaks are derived from the four cuts of the oven roast category (type I). As was the case for swiss steak, these four cuts are sliced during processing. Minute steaks differ from swiss steaks, however, in that they are smaller and have been mechanically tenderized. This tenderization process is by the needle (blade) method.

6-15. The whole cuts to be utilized for minute steaks are tenderized prior to freezing and slicing. The meat is tenderized by the repeated insertion of several knife-like blades into the cuts. This breaks up and shortens the length of each muscle fiber. The boneless cuts are tenderized by first conveying the cuts through the tenderizing machine, fat-side down. The cuts are then turned over and run through the machine. The cuts are once again turned fat-side up and run through the tenderizing machine. This process is also used in tenderizing the outside round when it is to be placed in the oven roast category.

6-16. Minute steaks weigh 3 or 4 ounces, depending on the contract. There may be a tolerance of plus or minus ¼ ounce. The length of each steak should not exceed the width by more than 1½ inches. Separate pieces of lean or fat may not be knitted together, and the tenderized steak should not fall apart when grasped at any point one-half inward from the edge and lifted from a flat surface.

6-17. *Type VIA, minute steaks (formed).* Type VIA steaks are processed in the same manner as are type VI steaks except that the tenderized cuts are frozen, tempered, and molded prior to slicing for the production of the formed minute steaks.

6-18. General Considerations. There are certain criteria that pertain to all fabricated beef cuts and can be discussed without referring to specific types or styles. No cut may possess more than one-half inch of external (surface) fat. All semiattached fat or tag ends must be removed. These are pieces of fat or muscle tissue exceeding 1 inch in length, which remain attached to a major cut, and will not support the weight of that cut when the cut is lifted by grasping the extreme one-third length of the semiattached fat or tag end.

6-19. All bruised or discolored tissues, lymph glands, and blood clots must be removed. All bone and cartilage greater than one-fourth when measured along the greatest length must be removed. No deep cuts, scores, or fractures are allowed. A deep cut or score is a slice in a cut of meat which penetrates the lean from the original lean surface in excess of 1 inch and is greater than 2 inches in length or width. A fracture is a crack in the surface of the lean tissue of a steak which penetrates more than one-half the thickness of the steak.

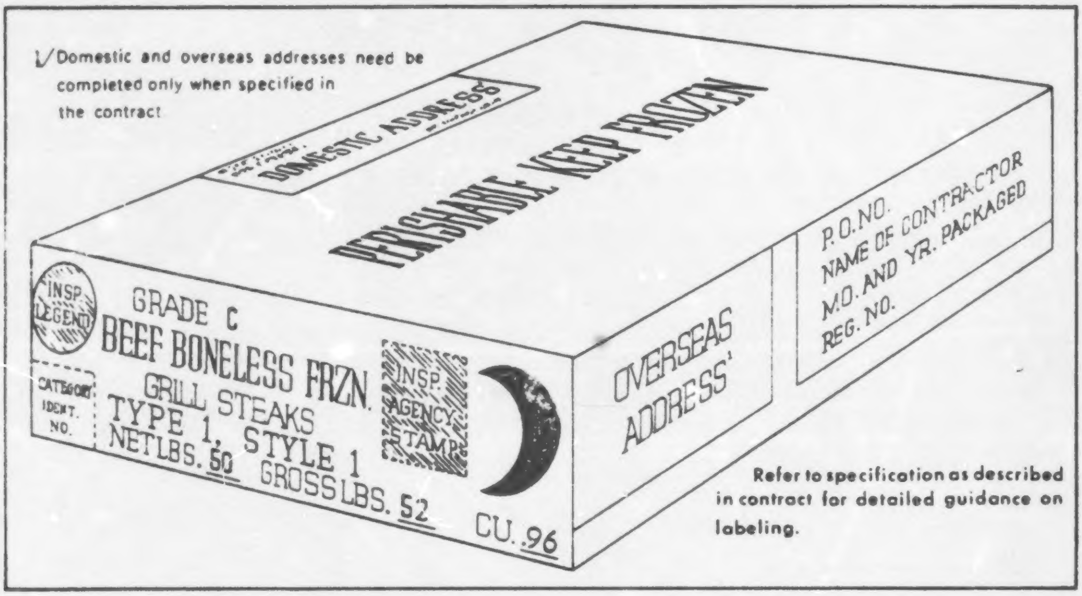
6-20. Ground and Diced Beef. Even though ground and diced beef is a form of fabricated beef, it is not a part of the *Beef Roasts and Steaks, Boneless, Frozen* specification MIL-B-43813. Instead, ground beef is purchased using the specification MIL-B-3854 *(Beef, Ground, Frozen)*, as the guideline for processing and inspection procedure. Diced beef is purchased using MIL-B-43698 *(Beef, Diced, Frozen)*.

6-21. *Ground beef.* Ground beef is prepared from chilled, freshly dressed beef carcasses, sides, quarters, or wholesale market cuts of USDA utility grade or better. The bone-in beef must be in excellent condition at the time of boning and show no signs of off-condition. The internal temperature at the thickest portion of the carcass, quarter, or wholesale cut must be between 28° F. and 40° F. at all times after initial chilling and prior to boning. The beef may not be from bull or stag carcasses. There is no carcass weight limitation.

6-22. Ground beef must be free of serous membrane, kidney, lymph glands, thymus glands, dehydrated tissue, brusies, blood clots, backstrap, and hanging tender. Bone and cartilage segments greater than one-fourth inch in any dimension are not allowed. The fat content of ground meat must not exceed 22 percent as determined by the thermal extraction method. The procedure for performing the thermal extraction method can be found in the ground beef specification.

6-23. Only the major criteria for ground beef production have been discussed. Packaging, freezing, and destination requirements can be obtained by referring to the specification.

6-24. *Diced beef.* Diced beef is commonly referred to as stew meat. The meat is sliced into pieces not more than 3 inches in length along any surface and weighing between ½ and 1½ ounces. The meat must come from



1/Domestic and overseas addresses need be completed only when specified in the contract

Refer to specification as described in contract for detailed guidance on labeling.

Figure 18. Labeling and marking the shipping container.

fresh chilled beef cuts of steers, heifers, or cows of a USDA grade equal to or better than that specified in the contract. Beef cuts from stags or bulls should not be accepted. The meat must be in excellent condition at the time of boning and processing and have an internal temperature at the thickest part of not less than 28° F. or more than 40° F.

6-25. The only cuts of beef that can be processed into diced meat are the primal rib, square-cut chuck, primal round, and full-trimmed loin. Diced beef cannot contain shank meat, protruding ligaments and tendons, backstrap, hanging tender, lymph glands, deckle, discolored or dehydrated tissue, or bone and cartilage in excess of one-fourth inch in length. There is no maximum fat content for diced beef but no individual piece of meat may exceed one-fourth inch in thickness measured from the edge of the lean.

6-26. **Inspecting and Packaging Boneless Beef.** Fab beef is prepared only in establishments that are under the inspection of the Animal and Plant Health Inspection Service, USDA. One of your responsibilities before the processing of the carcass into fab beef is to verify the grade, which is normally USDA good. To be acceptable, the carcasses must also carry an impression of the USDA "inspected for wholesomeness" stamp. This is an opportune time to verify weight ranges and classes (sex) with the purchasing document, and to look for other defects, such as bruises.

6-27. In accordance with the quality assurance provisions of Military Specification MIL-B-43813, the supplier (contractor) is responsible for performing all required inspections. He may, unless otherwise specified, use his own or any other inspection facilities and services acceptable to the US Government. Even so, the US Government reserves the right to perform any of the inspections indicated in the aforementioned specification. These inspections assure us that the product and services conform to prescribed requirements.

6-28. The examination system evaluation (ESE) also comes into use. This has already been discussed in detail in Volume 1, so we will not explain it again here. Fab beef is inspected by attributes according to the tables of examination in the specifications. It is impractical to expect you to learn all of these tables. Also, certain requirements specified by these tables are rapidly changing.

6-29. Labeling and marking individually wrapped or packaged meat cuts within the shipping containers is not required. Labeling and marking the shipping container, usually a fiberboard box, is illustrated in figure 18. Again, the contract, specification, and related documents should be checked to make certain that the container's labeling and marking are correct. For the most part, figure 18 is self-explanatory, although a few items deserve comment.

6-30. The circular area on the end of the box, which is marked INSP. LEGEND, is for the USDA stamp impression. The category identification, in the lower left corner of the end of the box, should also appear in the same position on the unmarked (opposite) end panel of the box. The category and subcategory are identified by the type and style printed on each box. For example, type I, style 1, placed on the box would indicate that it contains oven roasts and each roast is a knuckle. If there is no subcategory to a particular category, then only the type will be placed on the box. For example, since there is no style to type V, swiss steaks, only type V will appear on the box. Fab beef is normally packed in 50-pound boxes.

6-31. So far we have discussed the major requirements and criteria for the production of all forms of boneless beef. It is realized that not everyone will be involved with the class 3 inspection of boneless beef. If you are, then this chapter will not be complete enough for you to effectively perform your job. It is expected that you will study the specifications pertinent to your inspection responsibilities to gain the requirements not covered in this chapter.

6-32. If you are not involved with the class 3 inspection of boneless beef, but instead see it only at destination, then this chapter has given you some understanding of the basic requirements for the production of these products. The inspection of any form of fab beef at destination involves the standard inspection procedures that you would perform on any frozen food product. Freezer burn and evidence of thawing and refreezing will be your prime concern.

CHAPTER 3

Veal, Lamb, Pork, and Sausage Inspection

VEAL, LAMB, pork, and sausage inspection will be discussed in this chapter. Our discussion of veal will also include calf. Veal and calf are both derived from bovine, and you must learn to distinguish between them. You will learn about processing veal and calf. As an inspector, you must know their class, item number and product name, grade, state of refrigeration, and weight range.

2. Lamb represents over 90 percent of the sheep marketed for slaughter in the United States, but only limited quantities are consumed by the US Armed Forces. Lamb and its grouping into classes, grades, styles, and weight ranges will be covered here. We will also explain the refrigeration processes required in handling lamb, and the telescoped lamb and frozen boneless lamb procured by the Armed Forces.

3. Pork products constitute a very large portion of the meat included in military rations. As a veterinary specialist, you must know the principles for properly processing, grading, and inspecting pork. We will discuss styles, weight ranges, some major market cuts, and the storage of pork and pork products.

4. Sausage is meat that has been comminuted (reduced to small particles) and further processed. Many of the lower priced cuts of meat and trimmings are used for the production of all types of sausage products. Since sausage is procured in great quantities by the military, we will discuss the components of sausage and processing and inspection of the product.

7. Veal and Calf
(Chilled or Frozen)

7-1. The USDA defines the typical vealer as an immature bovine which is under 3 months of age and has subsisted largely on milk. Calves are usually between 3 and 8 months old and have subsisted partially or entirely on foods other than milk. Since the age of these animals is difficult to determine, no specific age limit is established as the dividing line. Because of their immaturity and lack of fat covering, both veal and calf carcasses are more perishable than beef.

7-2. The offspring of either the beef or dairy breeds of cattle develop acceptable veal or calf if it meets the USDA grade requirements. However, the beef types have a grading advantage over dairy types because they generally display superior conformation. Regardless of this fact, most veal is produced from dairy breed males because dairymen market their males at an early age and retain many of the females (heifers) to increase, maintain, or improve their herds.

7-3. Carcass Processing of Veal and Calf. The processing (dressing) of carcass veal and calf is similar to that of beef. The skinning process most often used for veal and calf carcasses is cold skinning. This is also known as round dressing and hog dressing because the skin or hide is not removed until after the carcass is chilled and presented for sale. The hide helps to retain a fresh appearance (bloom) by controlling loss of moisture. Dehydration (shrinkage) occurs rapidly in veal because of the high moisture content of the immature flesh. Normal shrinkage of cold skinned veal is about 2 percent and the weight loss assigned to the hide is 10 percent. This results in an average weight loss from the hot weight (before chilling) of 12 percent.

7-4. The method used during the "grub" season is called hot skinning. In hot skinning, the hide is removed at the time of slaughter and dressing. This method allows for inspection and the required trimming and is used for the processing of beef.

7-5. Differentiation Between Veal and Calf Carcasses. As we previously mentioned, a vealer is primarily milk-fed, whereas a calf has consumed more of other feeds than milk. These diets cause different development in

TABLE 4

Veal and Calf Grades and Grading Factors

Grade	Conformation	Finish	Quality
Prime	Broad, compact build tends to be thickly fleshed with a rather plump, well-rounded appearance. Rounds tend to be thick and bulging. Loin and back tend to be full and plump. Shoulders and breast tend to be thick.	A thin covering of firm fat over rump, loin, and back extending over the tops of the shoulders and the outsides of the legs. Modest fat streaking on inside of flank muscles, and modest fat covering over the diaphragm. Flanks are thick and firm. Kidney and pelvic fat is firm and moderately abundant.	Cut surface of lean is moderately firm, finely textured, greyish pink for veal or greyish red for calf. Texture is velvety to sight and touch.
Choice	Moderately blocky and compact, and broad in proportion to length. All parts are moderately thick fleshed; rounds are slightly bulged and thick.	A very thin covering for veal and a moderately thin covering for calf over back, loin, tops of shoulders and over the outsides of the legs. Moderate fat covering over the skirts and moderate fat streaking in the inside of flank musculature. Flanks are firm, full, and thick. Kidney and pelvic fat is firm and moderately abundant.	Moderately firm, finely textured, and light greyish red in calves, light greyish pink in veal carcasses.
Good	Slightly broad, compact, and blocky. Slightly thin fleshed with little or no evidence of plumpness. Loin, back, and rounds are slightly thin and nearly flat.	Extremely thin fat covering over back and loin, with practically no fat over tops of shoulders or outsides of legs. Only traces of fat streaking the flank and covering diaphragm. Small amount of kidney and pelvic fat.	Texture of lean is fine, but slightly soft and dark in color. Cut surface is rather moist to sight and touch.
Standard	Thinly fleshed, rangy, angular, and narrow in relation to its length. Rounds are thin, tapering, and slightly concave. Loin and back depressed. Shoulders and breast are thin.	External fat usually limited to very thin patches over the loin, back, and base of tail. Practically no fat streaking the inside flank muscles and over the diaphragm. Flanks are thin and soft. Only slight amounts of pelvic and kidney fat.	The cut surface of the lean is finely textured, but moderately soft, moist, and slightly dark. Greyish pink in color.

the body, which can be used to identify their carcasses after slaughter and dressing.

7-6. The differentiation between veal and calf carcasses is made primarily on the basis of the color of the lean, although such factors as the texture of the lean, the character of the fat, and the size and color of the rib bones are also considered. Typical veal lean has a grayish-pink color and is very smooth and velvety in texture. Veal also has slightly soft, pliable fat, and narrow, very red rib bones. By contrast, the lean of a typical calf carcass is a distinctly reddish color; the fat is harder and flakier; and the rib bones are somewhat wider, with less pronounced evidences of red color.

7-7. Classes. Class determination is based on the apparent sex condition of the animal at the time it is slaughtered. Veal and calf are classed in the same way as beef animals or carcasses are classed—as steers, heifers, and bulls.

7-8. Grades. The Armed Forces buy veal and calf in US grades prime, choice, good, standard, and utility. At least half of the carcasses purchased are choice or better. You should always consult the purchase document, because it states the grade to be purchased. The US grades are determined on the basis of three general grading factors—conformation, finish, and quality. Each of these grading factors is explained by grade in table 4.

7-9. State of Refrigeration. Veal and calf are purchased in two states of refrigeration—chilled and frozen.

7-10. *Chilled.* During the preparation of chilled veal or calf, the internal temperature of the thickest cuts must not exceed 42° F. The packaged product must have an internal temperature of not less than 30° F. nor more than 40° F. at the time of shipment and delivery.

7-11. *Frozen.* During the preparation of frozen veal and calf, the temperature requirements of the chilled product must be met. Within 4 hours after preparation, the product must be quick frozen using forced air circulation at a temperature of -10° F. or lower. The product must be distributed for rapid freezing so that surfaces are not in direct contact. After freezing, the product must be maintained at 0° F., or lower, during storage, shipment, and delivery.

7-12. Product Identification. The state of dress of the carcass and the wholesale market cuts are assigned item numbers for identification. For a complete description of each of these items, refer to Federal Specification PP-V-191 as amended.

7-13. Veal and calf carcasses must be sound, chilled, and unsplit, without the hide or caul fat. Sides and wholesale market cuts must come from such fresh-dressed carcasses. The internal temperature at the thickest portion of the carcass, side, or cut must be in the range of 30° to 40° F. Bone-in veal or calf

TABLE 5

Types, Categories, and Yield Percentages of Boneless Veal

Type	Category	Percentage Yield	
		Maximum	Minimum
I/II	1 - Slices	--	37
	2 - Roasts	--	25
	3 - Ground	38	--
III/IV	1 - Slices	--	55
	2 - Ground	45	--

showing any evidence of off-condition, including off-odor, stickiness, rancidity, or discoloration, or showing evidence of previous freezing or thawing is not acceptable. Trimming cuts for the purpose of meeting specified weights is not acceptable.

7-14. Weight Ranges. The weights of veal and calf are divided into three ranges, as follows: range 1, light weight; range 2, medium weight; and range 3, heavy weight. The weights for each range of veal and calf may be found in the specification.

7-15. Inspection. Veal and calf must be handled and delivered under the same sanitary conditions that govern the handling and movement of similar products within and between establishments maintained under Federal meat inspection standards. Sampling for inspection is done in accordance with specifications and MIL-STD 105, and at any time you may withdraw samples of the product or of the materials, components, or constituents entering into the preparation of the finished product, to determine contract compliance.

7-16. You may inspect the products at the site of preparation, both during processing and after processing when the product is ready for shipment. An inspection may also be made at a suitable place in transit or after delivery at destination. Passing the product as satisfactory does not relieve the contractor of his responsibility for faulty workmanship or an unsatisfactory product, which may be discovered at any time before final acceptance by the US Government. Contracts usually designate inspection points.

7-17. Unless otherwise specified, veal is delivered in commercial protective wrappers, coverings, or containers, suitable or applicable to the particular cut and its state of refrigeration. The wrapping and marking must comply with the specifications and the purchase order.

7-18. Boneless, Frozen, Fabricated Veal. Boneless, frozen, fabricated veal is prepared from chilled, fresh-dressed veal or calf carcasses, sides, or matched quarters (fore and hind). It is derived from USDA grades prime, choice, good, and standard. The grade of the carcasses for a specific contract must be equal to or better than the grade stated in the contract. The temperature in the thickest part of the bovine veal or calf is required to be between 28° F. and 40° F. before boning. The permissible wholesale cuts and maximum acceptable bone-in untrimmed weight for each is as follows:

Wholesale Cut	*Max. Wt. (lb)*
Hindquarter	80
Forequarter	80
Leg, with sirloin	65
Leg, without sirloin	52
Square-cut chuck	57

7-19. The types, categories, and percentage yield requirements (minimum and maximum) for boneless veal are shown in table 5. When the minimum percent of yield requirement for a category, as specified in this table, is not met, additional wholesale bone-in cuts may be obtained. These additional cuts must, however, be of the grade stipulated in the contract, or better, and meet the other requirements regarding temperature and condition. For the boneless cuts assigned to each category, study table 6. Both tables 5 and 6 are self-explanatory. Be assured that the information they contain is important to you as an inspector of boneless veal. Do not merely read these tables. Study them. Military Specification MIL-V-43299 gives additional detailed requirements for processing boneless veal.

TABLE 6

Category Assignment for Boneless Veal Cuts

Category	Cuts Assigned
1 - Slices	Knuckle Sirloin Rump and Butt Flank Steak Back (Rib and Loin) Tenderloin Heel Chuck Roll Chuck Tender Any cuts listed for Category 2
2 - Roasts	Top (Inside Round) Clod Bottom (Outside) Round with or without heel Chuck Roll with Chuck Tender attached
3 - Ground	Any cuts and authorized trimmings remaining from carcasses used in fulfilling Category 1 and 2 requirements. Any cuts listed for Categories 1 and 2

7-20. Boneless veal for freezing must be packed and in the freezer within 24 hours from the time boning starts. Veal slices must be in the freezer within 4 hours after being tenderized. Ground veal must be in the freezer within 4 hours after grinding. Veal roasts must be placed in the freezer within 4 hours after being packaged and packed.

7-21. The freezing equipment in the processing establishment must consist of a blast freezer, or its equivalent, to provide forced air circulation. The packaged product should be arranged in the freezer in the same way prescribed for the freezing of boneless beef. The freezer must be capable of reducing the temperature in the thickest part of the packaged product to at least 0° F. within 72 hours from the time it is placed in the freezer. Further, the internal temperature of the product cannot be higher than 0° F. at the time of shipment. The veal must be in excellent condition at this time, showing no evidence of thawing or refreezing up to and including the time of acceptance at destination.

8. Lamb

8-1. What is commonly called lamb is in reality ovine. Ovine (sheep) includes all ages of the species, and lamb refers to only the young within the species. Certain characteristics of lamb are unexcelled by the edible meat from other animals. Two of these characteristics are the exceptional degree of its tenderness and the fine texture found in the better grades and classes of lamb.

8-2. *Classes.* We do *not* differentiate between ovine sexes as ram, ewe, or wether. Classes represent age groups or maturity of the animal. We purchase three different classes or age groups: lamb, yearling mutton, and mutton:

a. A lamb is an immature ovine, usually under 14 months of age, that has not cut its first pair of permanent incisor teeth.

b. A yearling mutton is usually between 1 and 2 years old, and has cut its first pair of incisor teeth but has not cut its second pair.

c. A mutton is usually over 24 months old and has cut its second pair of permanent incisor teeth.

8-3. When you are determining the maturity class of ovine carcasses, you must give more consideration to the characteristics of the flesh than to the characteristics of the skeleton. To help you determine age differences between lamb, yearling mutton, and mutton, observe the four basic characteristics listed in table 7. You will notice that in order to be classed as lamb, a

TABLE 7

Basic Chracteristics of Age Differentiations for Ovine Carcasses

	Lamb	Yearling Mutton	Mutton
Foreshank	Break joints on both front shanks	Either break joints or "spool" joints on front shanks	Spool joints on front shanks
Rib bones	Narrow, much red marrow	Moderately wide, little trace of red	Wide, no red marrow
Lean	Light red, fine texture	Rather dark red, slightly coarse	Dark red and coarse
Conformation	Smooth and regular	Slightly irregular	Definitely irregular

carcass must have break joints on both its front shanks. Yearling mutton carcasses may have either break joints or spool joints. Mutton carcasses always have spool joints.

8-4. *Foreshank Inspection.* The inspection of the foreshank for break joints and spools should not be the only determination of age you use, but it does provide good information to combine with the other characteristics. Figure 19 illustrates the different conditions of the carpal joints on the distal end of the shank after the front feet are broken off. In the young animal the bones are soft. As the animal ages, the bones ossify and harden. The carpal joint in a lamb is soft and the distal ends of the ulna and radius break off when the feet are removed, leaving a rough projection called a break joint. As the animal grows older, the bones become harder, and more and more of the knob remains attached to the bone after breaking. When the animal reaches maturity, the entire knob remains attached to the bone when the feet are removed:

a. Break joint. For a joint to be classed as a break joint, four rows of toothlike projections must be exhibited, with two projections on each row. These projections are velvety to the touch and reddish in appearance in young carcasses. As the animal's age increases, the reddish color diminishes, and the projections become rougher and eventually disappear because of ossification.

b. Yearling joint. When the feet are twisted

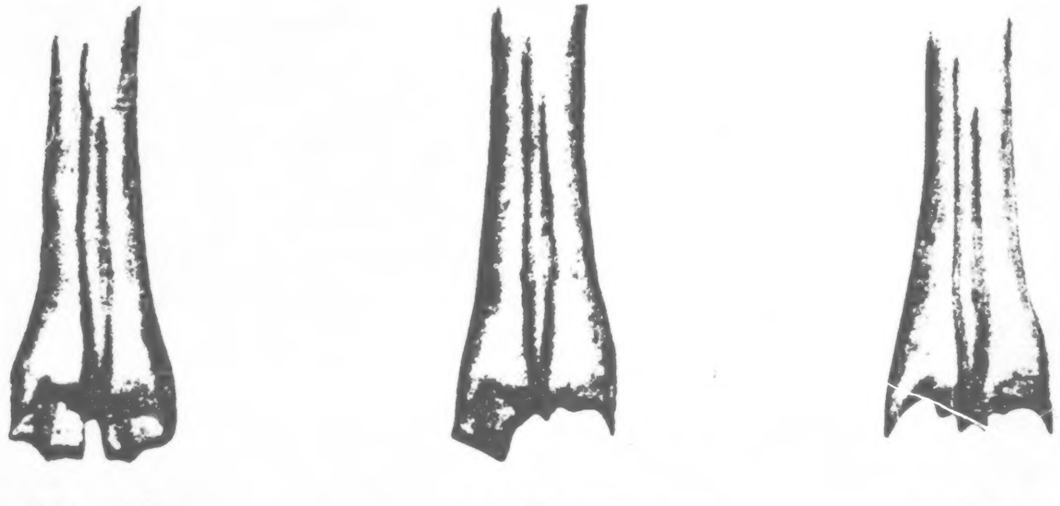


Figure 19. Distal end of an ovine foreshank separated from foot.

off a yearling, part of the knob remains on the bone and part is attached to the foot. Notice that on the left side of the yearling joint in figure 19 part of the head is attached to the bone.

c. Mutton spool joint. In a spool joint the entire knob remains attached to the bone during separation of the foot.

8-5. You might inspect carcasses minus both the spool and break joints (front shanks). In such instances, you should assume that the carcasses had spool joints before removal of the shank. Because of this, you can classify these carcasses according to their other characteristics only.

8-6. *Color and texture of the lean.* Another important age-determining factor is the color and texture of the lean meat. This factor is determined primarily by examining the flank muscle. Carcasses from younger animals exhibit light pink, firm flesh in the flank muscle. In comparison, older animal carcasses exhibit very dark red, soft, and watery flesh in this same area.

8-7. *Conformation.* Conformation is also an age-determing factor or indication of maturity. However, certain aspects of conformation are too often misused in the determination of age or stage of maturity. Sharp shoulders, long tapering legs, and narrow thin backs are not directly associated with the maturity of lamb, but rather are more characteristic of certain breeds. Therefore, carcasses containing such conformation are not uncommon. The aspects of conformation that are important to us in determining maturity are the "spreadiness" through the forequarter and, to a lesser extent, the "barrelness" of the body as viewed from the back. There is a distinct tendency for a lamb to become more "spready" through the forequarter and more "barrelly" through the body as the animal matures.

8-8. *Fat covering.* Little explanation is needed about outer fat covering, which is the final age-determining factor to be considered. This fat is more evenly distributed in young lamb carcasses. In older carcasses, the outer fat is unevenly distributed and is also patchy, especially over the loin, pelvic, and neck regions.

8-9. Grades. Not to be confused with market classes (lamb, yearling mutton, and mutton) are the grades of lamb and mutton established by the USDA, though these grades include some of the same requirements that differentiate between the market classes. There are five USDA lamb grades—prime, choice, good, utility, and cull. Our discussion will be limited to the top three, because they are the grades usually procured. Mutton carcasses may not be graded prime.

8-10. Ovine grading is similar to beef grading. Lamb, yearling mutton, and mutton carcasses are graded on a composite evaluation of the two general grade factors, conformation and quality, as shown in table 8.

8-11. Styles and Weight Ranges. Besides being identified according to class and grade, ovine meat is further divided into styles, cuts, and weight. There are three styles:

- Style I—carcass.
- Style II—fabricated carcass.
- Style III—wholesale market and fabricated cuts.

The 17 different meat cuts in style III are listed in the left-hand column of table 9, which also gives the weight ranges for each class.

8-12. States of Refrigeration. Ovine meat may be procured either chilled or frozen. The chilled product must be thoroughly chilled, but not frozen, to a temperature of 40° F. or lower at the bone in the thicker portion of the leg or shoulder, promptly after slaughter in accordance with good commercial practice. The product must be in excellent condition and in a thoroughly chilled state at delivery. The lamb must not show evidence of freezing or defrosting.

8-13. The frozen product must be thoroughly frozen in a sharp freezer, or in a wind tunnel, in suitable and reasonable uniform temperatures not higher than 0° F. Products thus frozen must be maintained and delivered in a solidly frozen state. The products must show no evidence of defrosting, refreezing, freezerburn, contamination (chemicals, ammonia, brine, rodents, insects, dirt, rust, etc.), or any other detrimental blemish, deterioration, or damage.

8-14. Wholesale Cuts and Fabricated Lamb. Because the amount of lamb procured is not large, it is unlikely that you will need to know *how* the wholesale market cuts (style III) are obtained from the carcass. You do need to know, however, that Federal Specification PP-L-92 contains this information, along with other detailed requirements. Always have a copy of this specification and related documents in hand when you are inspecting lamb.

8-15. *Telescoped lamb.* Frozen telescoped lamb differs from carcass and wholesale cuts

TABLE 8

Grades of Lamb Normally Procured by the US Armed Forces

Grade	*Conformation*	*Ribs*	*Breakjoints*	*Flanks*	*External Finish*
Prime	Compact, blocky with plump, full legs. Back wide and thick. Shoulders thick, smooth and full. Neck short and thick.	Red and narrow to slightly red and slightly narrow Moderate to rather extensive feathering between the ribs. Small to moderate amount of overflow fat over the inside of the ribs adjacent to the backbones.	Red, moist, porous to rather dry and hard.	Inside flank muscle light pink to dark pink color, modest to slightly abundant quantity of fat streaking. Flanks full and firm to very full and firm.	Firm to very firm.
Choice	Slightly compact, with slightly plump full legs. Back slightly wide and thick. Shoulders slightly wide and full. Neck slightly short and thick.	Red and narrow to slightly red and slightly wide. Small to moderate amount of feathering between the ribs. Slight to small amount of overflow of fat over the inside of the ribs adjacent to the backbone.	Red, moist, porous to rather dry and hard.	Inside flank muscle slightly dark pink to dark pink in color, slight to small amount of fat streaking. Flanks slightly full and firm to moderately full and firm.	Moderately firm to firm.
Good	Moderately rangy and slightly angular, with slightly thin, tapering legs. Back slightly thin and narrow. Shoulders slightly thin and narrow. Neck moderately long and thin.	Red and narrow to slightly red and slightly side. Traces to slight amount of feathering between the ribs. Practically no overflow fat over the ribs adjacent to the backbone.	Red, moist, porous to slightly red, but rather dry and hard.	Inside flank muscle dark pink to slightly dark red in color. Practically no fat streaking to traces of fat streaking. Flanks slightly thin and soft to slightly full and firm.	Slightly firm to moderately firm.

only to the extent that it is cut differently. It is prepared from lamb carcasses weighing between 30 and 60 pounds, of the grade desired. The name "telescoped" means that the entire carcass is procured but it has been prepared in such a manner as to make it more compact.

8-16. The lamb carcass is first chilled, and then the lower foreshanks are removed at the knees. The hind legs are separated from the carcass by a cut in front of and close to the hip bones. This cut is made perpendicular to the chine bone. The lower hind shanks are removed at the hock joint. After removal of the shanks, the hind legs are placed inside the carcass and pushed forward (telescoped) into the chest cavity. Finally, the carcass is tightly tied with a strong cord, which is run through each flank with a needle. The product is then placed into a sharp freezer or wind tunnel to be rapidly frozen. The temperature requirements for telescoped lamb are the same as for frozen carcass lamb.

8-17. *Boneless lamb*. Like beef and veal, lamb may be processed to remove the bones. Lamb, boneless, frozen, fabricated, consists of type I, leg roasts, and type II, shoulder chops. They are produced from carcasses which grade prime or choice. The product, before boning, must be fresh, chilled, dressed carcasses or wholesale cuts. The lamb must be in excellent condition at the time of boning. There should be no evidence of such conditions as off odors, stickiness, rancidity, souring, or discoloration. Further, it should be free of foreign material, such as dirt, sawdust, and insects.

8-18. *Weights*. The permissible wholesale market cuts and their maximum allowable untrimmed weights are as follows:

Wholesale Cut	*Maximum Weight (lb)*
Foresaddle	33
Chuck, double	23
Shoulder, double	16
Hindsaddle	33
Legs, double	23
Hindsaddle, long cut, regular	42

Whole carcasses, from which the wholesale market cuts are derived, can weigh no more than 65 pounds. Cuts are derived from the carcass as described in military specification MIL-L-43510.

8-19. *Temperatures*. The internal temperature of bone-in lamb should be between 28° F. and 40° F. after the initial chilling and before boning. Other temperature requirements are as follows: The temperature in the thickest part of chilled, boned lamb may not exceed 42° F. upon completion of fabrication and placing in the freezer. Both type I and type II must be completely processed, including wrapping and packing, and be placed in the freezer within 24 hours from the beginning of the boning operation. An exception is when boneless shoulders are sliced. Before slicing, they should be frozen to 0° F. The shoulders are then removed from the freezer and sliced. The sliced shoulders

TABLE 9

Weight Ranges for Styles I, II, and III Lamb

	Range I			Range II			Range III			Range IV		
	Lamb	Yearling Mutton	Mutton	Lamb	Yearling Mutton	Mutton	Lamb	Yearling Mutton	Mutton	Lamb	Yearling Mutton	Mutton
I Carcass	30-41	45-60	55-75	42-53	61-76	76-95	54-65	77-92	96-115	66-75	92-104	116-130
II Carcass, Fabricated	30-41	45-60	55-75	42-53	61-76	76-95	54-65	77-92	96-115	66-75	92-104	116-130
III Wholesale Market & Fabricated Cuts												
Foresaddle	15-21	23-30	28-38	21-27	31-38	38-48	27-33	39-46	48-58	33-38	46-52	58-65
Bracelet (double)	5-6	7-10	8-11	6-8	8-11	11-14	8-10	11-14	14-17	10-12	14-16	17-19
Hotel Rack, Trimmed (double)	3-5	5-7	6-8	5-6	6-8	8-10	6-7	9-11	11-13	7-8	10-12	13-14
Chucks and Plates (double)	12-16	18-28	22-30	17-21	27-35	30-38	22-26	36-43	38-46	26-30	44-49	46-52
Chucks (double)	11-14	16-20	19-26	15-19	23-27	27-33	19-23	28-32	34-40	23-27	32-36	41-46
Shoulders (double)	8-10	12-15	14-19	11-13	16-19	19-24	14-16	19-22	24-29	17-19	23-26	29-33
Shoulders (boned, rolled, tied)	3-4	4-6	6-8	4-6	6-8	8-10	6-7	8-10	10-12	7-8	10-12	12-26
Breast and Shank	4-6	7-10	8-11	6-7	5-11	11-13	8-9	10-13	13-16	10-11	13-14	16-18
Hindsaddle	15-21	23-30	28-38	21-27	31-38	38-48	27-33	39-46	48-58	33-38	46-52	58-65
Loin, Regular (double)	5-6	7-9	8-11	7-8	8-11	11-14	8-10	11-13	14-17	10-11	12-14	17-20
Loin, Trimmed (double)	3-4	5-7	6-8	4-5	5-8	8-10	5-7	8-9	10-12	7-8	8-10	12-15
Legs (double)	11-14	16-22	19-26	15-19	23-27	27-33	19-23	28-33	34-40	23-27	34-38	41-46
Leg, Oven-Prepared	4-6	7-8	8-10	6-8	8-10	11-13	8-9	10-13	14-16	9-11	14-16	16-18
Back, Regular	9-12	13-17	17-23	13-16	17-22	23-29	16-20	23-28	29-35	20-33	29-34	35-39
Back, Trimmed	6-8	9-11	11-15	8-11	12-15	15-19	11-13	16-19	19-23	13-15	20-23	23-26
Hindsaddle, Long-Cut, Regular	20-27	28-35	36-49	27-34	36-48	49-62	35-42	49-60	62-75	44-49	61-74	75-85
Hindsaddle, Long-Cut, Trimmed	17-23	24-29	30-41	23-29	30-41	42-52	30-36	42-52	53-63	36-41	53-63	64-72

must be returned to the freezer within 2 hours.

8-20. Blast freezers (or the equivalent), capable of providing forced air circulation while maintaining a freezer temperature of -10° F. or colder during the freezing process, are required. The packages should be arranged in the freezer so that their surfaces are not in direct contact for at least 24 hours after the start of the freezing process. They may thereafter be restacked in a more convenient arrangement. The product must remain in the freezer until the temperature is no higher than 0° F. in the thickest part of the lean. After being frozen and until delivered at destination, boneless lamb, frozen, should be kept at 0° F. It should be in excellent condition when delivered, showing no evidence of thawing or refreezing.

8-21. Lamb for boning must be processed in establishments that are operated under the *Regulations Governing Meat Inspection*, USDA. The contractor, unless otherwise stipulated in the purchasing document, is responsible for all in-processing inspection. However, the US Government reserves the right to perform any of these inspections whenever necessary to assure that the products and services conform with prescribed requirements.

9. Pork

9-1. Examine the following statements:

- Pork products generally have a high ratio of fat to lean and are sources of high energy food.
- Consumption of saturated fats, such as lard, contributes to circulatory problems and heart trouble.
- Trichinae can infect fresh pork.

Does the information presented in these statements stimulate your taste and desire for fresh pork? Probably not. Other consumers, as well, have been encouraged to eat less fresh pork. The amount of uncured pork purchased in recent years has declined drastically. At the present time, probably less than one-fourth of all pork porducts are consumed as fresh meat.

9-2. Changed requirements in the industry have even caused the breeding of different types of hogs. The "lard" type of hog, which produces fat cuts of meat and large quantities of lard, is no longer desired. Instead, the long, lean, "meat" type of hog demands the premium price, for it produces the most bacon, ham, and loin. These are the cuts that are popular and are, therefore, more valuable. Of these cuts, only the loin is ordinarily consumed as a "fresh" product; the others are cured.

9-3. Do not misunderstand! Pork is still included in the diet of the average person, and pork products constitute a very important part of the meat in military rations. You will need to know the principles for properly processing, grading, and inspecting pork. Also, because most of these products are cured, we will discuss the methods and procedures used in the curing process. With this information, you should be able to recognize the characteristics of both acceptable and unfit pork.

9-4. The processing of pork is much the same as that of beef with the exception of scalding and skinning. After stunning and bleeding, pork carcasses are immersed in vats of scalding water at temperatures of 136° F. to 140° F., for 4 to 4½ minutes, to loosen the hair. Dehairing is accomplished by machine or depilatory methods. Eviseration and washing are similar to procedures used in beef, but shrouding is not required prior to chilling since the skin is not removed during processing. Splitting and removal of the head are accomplished according to the specification styles, which are discussed in the following paragraphs.

9-5. Styles. There are two styles of pork—style A is carcasses and style B is market cuts. Style A is graded, and style B is divided into either selection 1 or selection 2.

9-6. Style A carcasses are of the US grade specified in the contract. They are dressed "packer-style," which means that the heads, plucks (liver, heart, lungs), kidneys, ham facings, and leaf fat, as well as the lumbar, pelvic, and heart fat, and the mediastinal tissue are removed. Each carcass is separated into two halves.

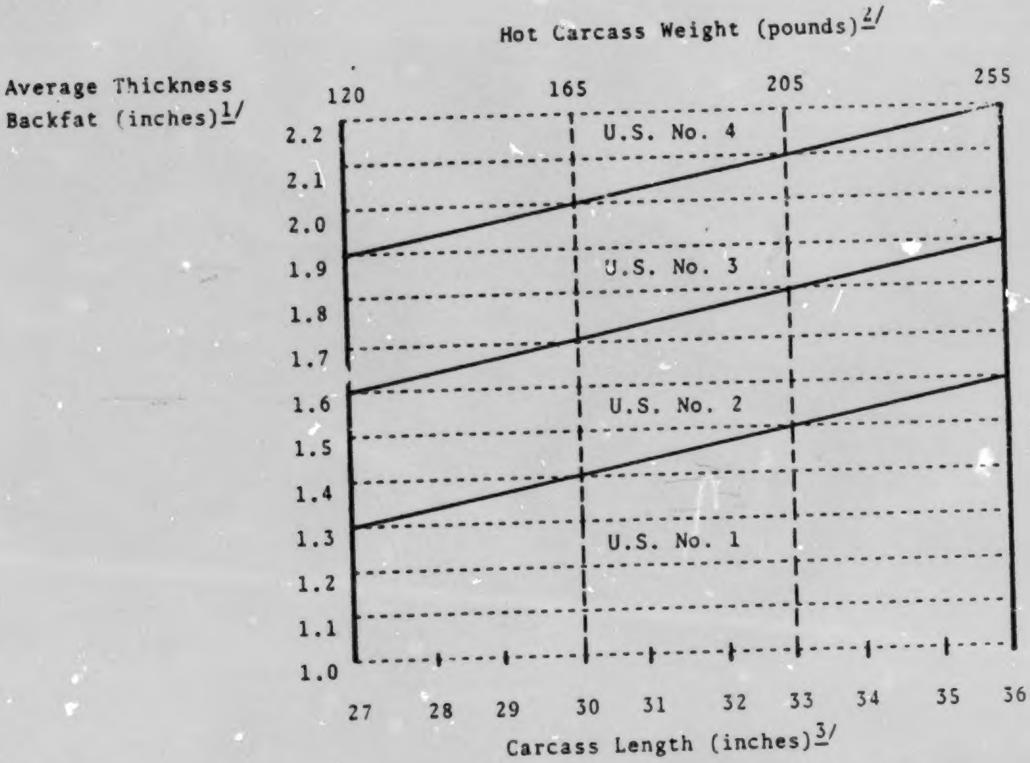
9-7. Style B market cuts are derived from style A pork carcasses. The list of the market cuts with their weight ranges may be found in the specification.

9-8. Grades and Grading Factors. Federal carcass grades for style A pork carcasses are determined by the relationship between the average thickness of the backfat, the carcass length and weight, and the amount of muscling.

9-9. *Backfat.* Backfat is the fatty layer found dorsal to the loin. Table 10 shows the relationship between backfat and length. To use this grading factor chart, first measure the thickness of the backfat, then the carcass length, and apply them to the chart. Find the intersection of a line drawn on the chart vertically from the carcass length and the dashed horizontal line from the inches of

TABLE 10

Pork Grading Factors



1/ An average of three measurements including the skin made opposite the first and last ribs and the last lumbar vertebra. It also reflects adjustment, as appropriate, to compensate for variations - from - normal fat distribution.

2/ Carcass weight is based on a hot packer style carcass.

3/ Carcass length is measured from the anterior point of the aitch bone to the anterior edge of the first rib.

backfat listed in the left-hand column. When the intersection falls anywhere between the bottom of the chart and the first solid diagonal line from the bottom, the indicated grade is US number 1, but the third factor (muscling) must be included before a final grade is reached.

9-10. *Muscling*. The degree of muscling for each grade decreases progressively from US number 1. The degrees of muscling applied to the carcasses are: US number 1—thick; US number 2—moderately thick; US number 3—slightly thin; and US number 4—thin. These definitions of muscling are subjective, and USDA graders learn them through training and experience. There are pictures that attempt to show the muscling, but there is no substitute for experience. If you desire more information on muscling, consult Marketing Bulletin Number 49, *USDA Grades for Pork Carcasses.*

9-11. *Compensation*. In each grade, a superior development of muscling is permitted to compensate for a greater average backfat thickness at the rate of one-tenth inch greater backfat thickness for a full degree of superior muscling. Except for the US number 1 grade, the reverse type of compensation is also permitted at the same rate. In the US number 1 grade, this compensation is limited to one full degree of inferior muscling.

9-12. *Grade descriptions.* Hogs within the US grades are described below:

a. US number 1 slaughter hogs have a minimum degree of finish and yield high-quality pork cuts. The carcasses have a relatively high ratio of lean to fat and yield more than 50 percent of their weight in the major lean cuts: hams, loins, picnics, and Boston butts.

b. A US number 2 pork carcass may be slightly fatter than necessary to produce high-quality pork, and the cuts require considerable trimming. Such carcasses normally yield from 47 to 50 percent of the major lean cuts.

c. US number 3 grade pork carcasses are from overfat hogs that yield a low proportion of lean cuts and a high proportion of fat. The yields of the lean cuts are usually less than 47 percent.

d. US number 4 hog carcasses have an acceptable quality of lean but a lower expected yield of lean cuts than carcasses in US number 3 grade.

e. The lowest grade, US utility, is given to a carcass that exhibits smaller developments of lean quality than the minimum described for the first four. Also included in this grade are all carcasses that do not have acceptable belly thickness and all carcasses—regardless of their development of other quality-indicating characteristics—that are soft and oily.

9-13. Wholesale and Market Cuts. When a pork carcass is divided, it yields nine wholesale cuts. These are shown in figure 20. Examine this illustration thoroughly so that you can easily recognize each cut. Some of the wholesale cuts can be trimmed or cut in several ways. For instance, a regular ham can be processed with the shank on, with a short shank, or with the shank off. Shoulder picnics can be processed in a similar way, and bellies are processed with the skin on or off. These variations are identified by a number with the code letter. For example, the short shank and shankless varieties of regular hams are coded as "a-1" and "a-2" respectively.

9-14. Cutting Procedure. After hog carcasses are thoroughly chilled, they are delivered to the cutting room where they are divided into market cuts. Accurate cuts depend on thorough chilling. Cuts formed from hot carcasses can become distorted from shrinkage. Each side of a pork carcass is divided into the anterior, middle, and posterior portions. We will discuss these portions in the order in which they are removed from a carcass:

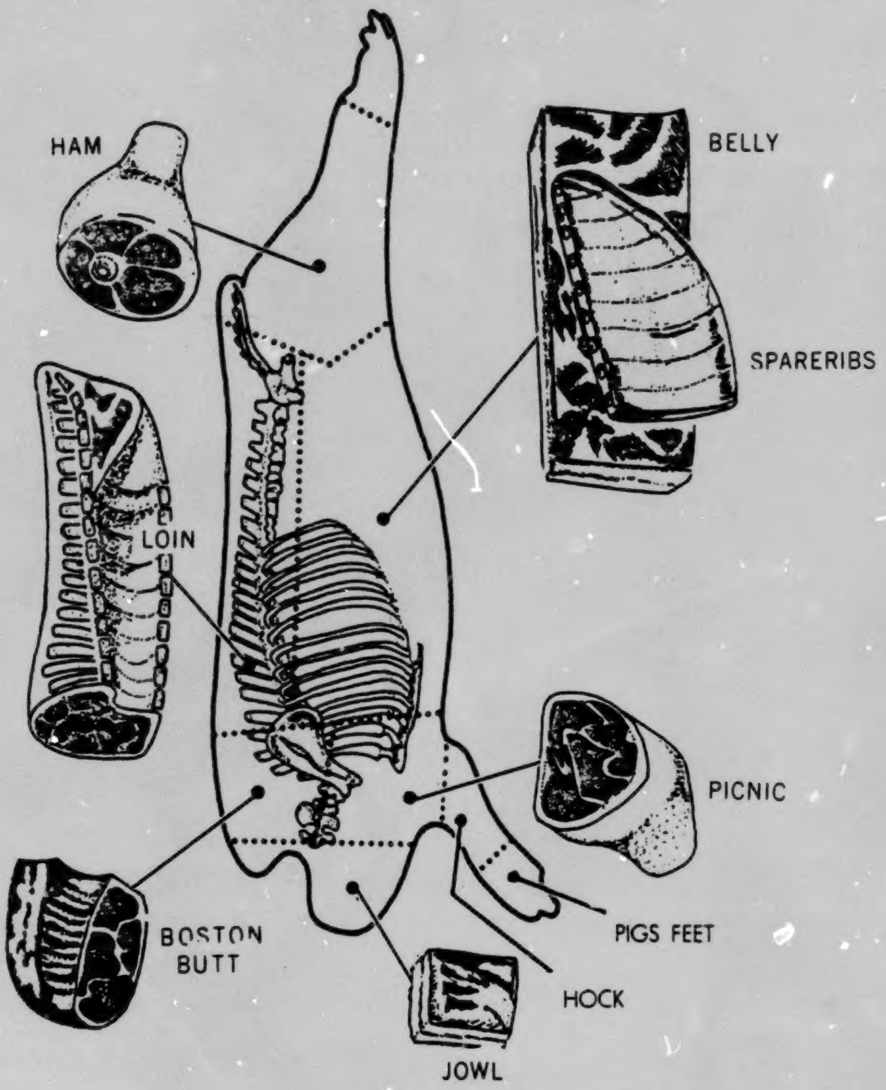
a. Posterior. As the chilled carcass arrives in the cutting room, the skin attachments between the two sides are severed and the gambrel cord is cut, permitting the sides to drop separately on a moving conveyor line. The posterior is removed first. To form this portion, a line is cut perpendicular to an imaginary line drawn through the center of the shank to the tip of the aitchbone. The perpendicular line should be 2¼ to 2¾ inches below (anterior to) the aitchbone, or about the width of three fingers. The posterior portion is then divided into three parts—the ham, tail, and foot.

b. Middle. The middle portion is formed by the removal of the anterior portion from the remainder of the side. A cut is made by a large circular saw on a line perpendicular to the chine bones, leaving not less than one nor more than two and a half ribs on the anterior portion. The loin, spareribs, and belly come from the middle portion. After the back fat is removed from the loin, it is referred to as "fatback."

c. Anterior. The anterior of the carcass is the part that remains after the middle and posterior portions have been removed. About one to two and a half ribs are left on the anterior portion. It is then divided into the Boston butt, picnic, hock, jowl, and pigs feet. See figure 21 for the shoulder cuts.

9-15. Pound for pound, bacon and ham procurement exceeds all other pork procurement. It is necessary, then, that you know the military requirements for these products. Curing and smoking will be discussed later. The fresh market cut that is processed into bacon is the belly. This cut is illustrated in figure 22. Before curing, it is called a green belly.

9-16. *Bellies (bacon).* Bellies are of two kinds, skin-on and skinless. The only difference between them is evident in their names. The skin-on belly is the part of the pork side middle after the removal of the loin, fatback, and spareribs. The belly is boneless, and the major cartilages of the sternum and the ribs are removed closely and smoothly. Practically all leaf fat and other abdominal surface fat of similar character are removed. The sides of belly are straight and parallel, and at right angles to the shoulder end. The belly is separated from the fatback on a straight line, not more than 1½ inches beyond the outermost curvature of the scribe line (point of separation of ribs from belly). The ham end of a belly may be cut on an angle so that the flank side is about 1 inch longer than the fatback side. Any enlarged, soft, porous,


HAM
BELLY
SPARERIBS
LOIN
PICNIC
BOSTON BUTT
PIGS FEET
HOCK
JOWL

- HAM
  - Butt end
  - Shank end
  - Center slices
  - Long shank
  - Short shank
  - Hock
- LOIN
  - Loin chops
  - Rib chops
  - Loin and rib roasts
  - Canadian Style bacon
  - Tenderloin
  - Backfat
- BELLY
- SPARERIBS
- BOSTON BUTT
  - Boston butt roast
  - Blade steaks
  - Regular plate
  - Clear plate
- PICNIC
  - Picnic roasts
  - Arm steaks
- JOWL
  - Jowl bacon square
- HOCK (Shoulders)
  - Shank
- PIGS FEET

NOTE: The shoulder is comprised of the Boston butt, picnic, and hock. The shoulder picnic is comprised of the picnic and hock together.

Figure 20. Skeleton of the pork carcass.

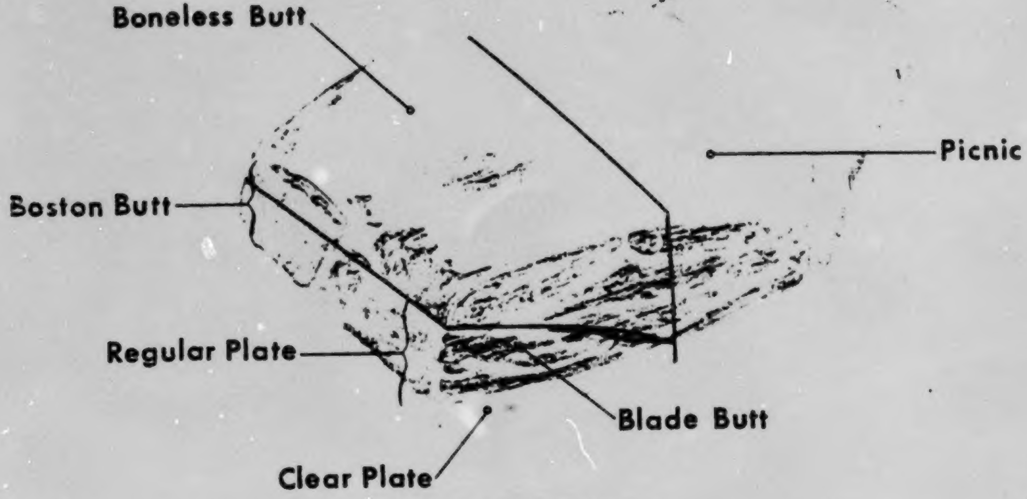

Boneless Butt
Picnic
Boston Butt
Regular Plate
Blade Butt
Clear Plate

Figure 21. Pork shoulder cuts.

seedy mammary tissue, and the pizzle recess of barrow bellies are removed. The bellies must not be less than 8 inches nor more than 11 inches wide. In addition, they must not be less than 1 inch thick at the thinnest point nor more than 2¼ inches at the thickest point.

9-17. After the belly is cured and smoked, it is processed and procured in two forms and two classes of bacon. If the side of bacon is left uncut, it is form A, slab. When it is sliced, it is form B. The class is determined by the kind of refrigeration used to prevent deterioration. Class 1 bacon is chilled, while class 2 is frozen.

9-18. *Ham.* There are six different varieties of ham. Figure 23 illustrates the various parts of a ham. Consider this illustration carefully as we discuss the characteristics of each variety of ham.

9-19. The regular, shank-on ham (code a) is, as its name indicates, a regular ham with the shank and skin on. It is separated from the hog carcass at a point ranging from 2¼ to 2¾ inches anterior to the exposed knob end of the aitchbone. Unless otherwise specified in the procuring documents, hams with exposed bone marrow are acceptable. Of course, the tail and tail bones are removed.

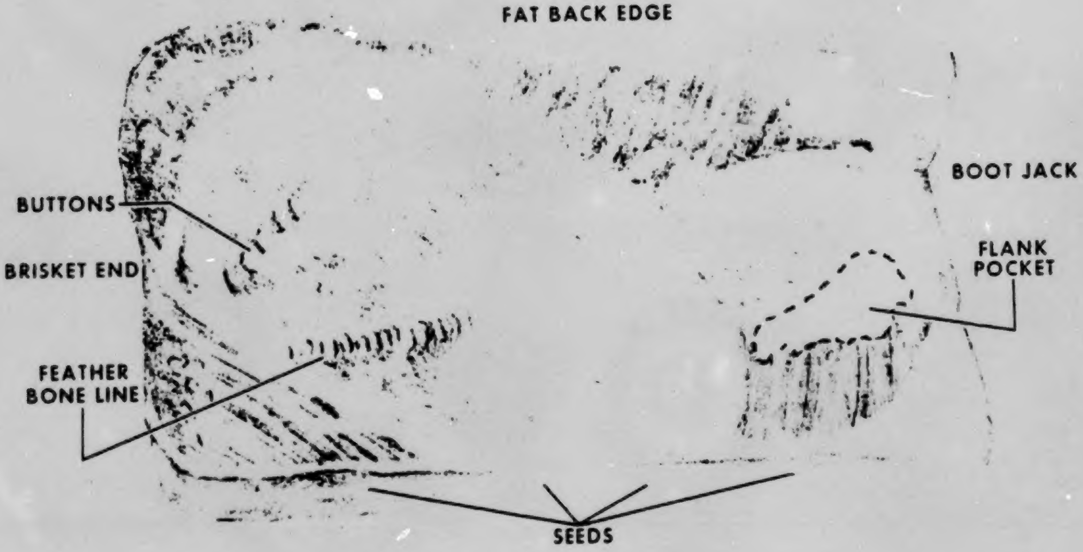

FAT BACK EDGE
BOOT JACK
BUTTONS
BRISKET END
FLANK POCKET
FEATHER BONE LINE
SEEDS

Figure 22. Bacon.

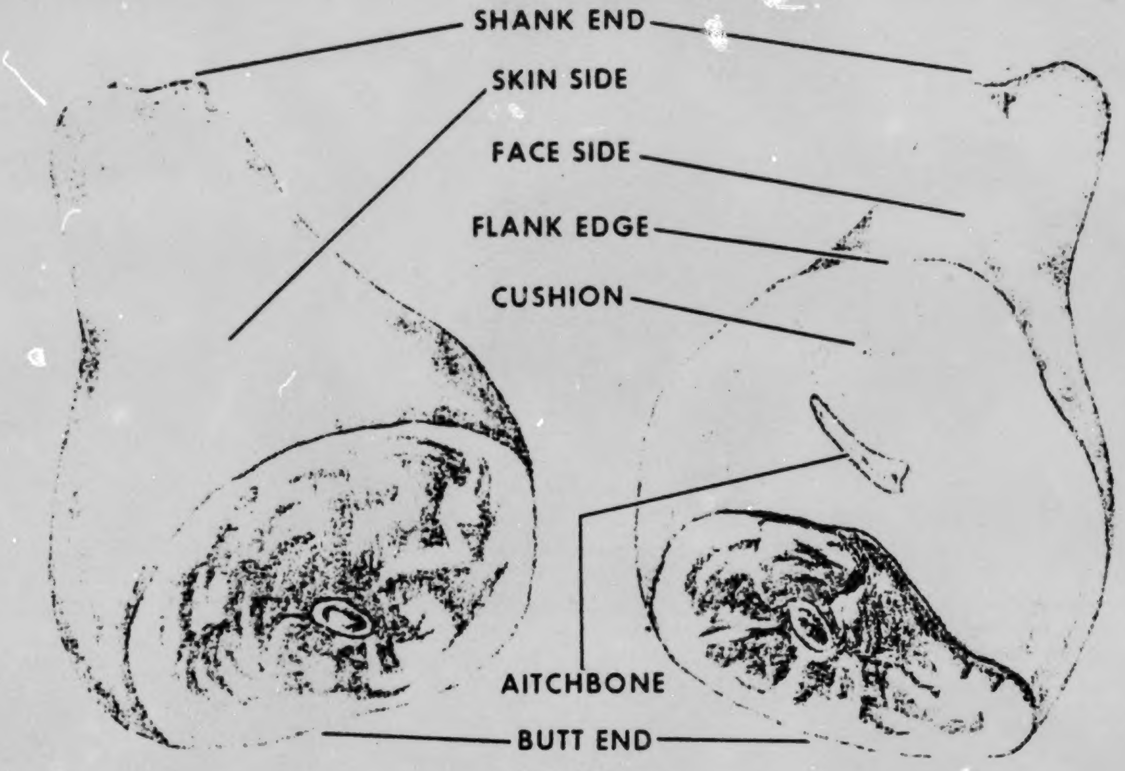


Figure 23. Ham.

9-20. The ham with a short shank (code a-1) is identical to the regular ham (code a) with one exception. The short shank does not extend more than 2 inches from the junction of the thick meaty cushion of the ham. The shankless ham (code a-2) is a skin-on ham conforming with the requirements of the regular ham except that the shank bone is removed at the stifle joint.

9-21. The partially skinned, shank-on ham (code b) is the same as the regular ham except that it is partially skinned on the back, leaving a smooth skin collar at the shank. This skin collar cannot exceed 45 percent of the entire back (skin side) surface of the ham. You can find the percentage of the back surface that is covered by the collar by determining its proportion of the lengthwise measurement from the approximate center at the edge of the ham butt to the extreme outer tip of the shank end. The fat must be neatly beveled so that it meets the lean meat at the butt end of the ham.

9-22. The partially skinned, short shank ham (code b-1) must comply with the requirements of the shank-on ham (code b), with the same removal of the shank as for code a-1 hams. The skin collar of b-1 hams cannot be more than 15 percent of the distance from the center, at the edge of the butt, to the stifle joint. Partially skinned, shankless hams (code b-2) must comply with the requirements for code b-1 hams, with the shank portion removed to conform with the requirements for code a-2 hams.

9-23. Cured, smoked hams are either type I, standard, or type II, special. Military Specification MIL-H-1287 lists the differences between type I and type II. These differences lie primarily in the areas of skin, shanks, moisture, fat, and salt percentages. Standard hams are processed only as chilled (class I) hams, while special hams may be either chilled (class I) or frozen (class 2).

9-24. State of Refrigeration. Fresh pork is either chilled or frozen as specified by the purchase instrument. If this is not specified, fresh pork is in a chilled state.

9-25. *Chilled.* Chilled pork must be thoroughly chilled, but not frozen, promptly after slaughter to an internal temperature range of 28° F. to 40° F. at the center of the thickest pieces. It must be kept in this well-chilled state (not frozen) and be in excellent condition at the time of delivery.

9-26. *Frozen.* Frozen pork must conform to the requirements of chilled pork before the freezing process. However, within 4 hours after packing, it must be frozen in a blast freezer with forced air circulation that maintains a temperature of -10° F. or colder. The packages must be arranged so that their surfaces are not in direct contact for at least 24 hours, until the temperature in the thickest part of the lean meat reaches 0° F. or lower, and must remain at this temperature during storage and shipment.

9-27. *Time limits.* The time between manufacture and consumption of chilled, standard hams is limited to 3 to 4 weeks. Chilled special hams may be retained 4 to 5 weeks before being consumed. If special hams are frozen, they may be consumed up to 6-9 months after manufacture.

9-28 Boneless Pork, Frozen. Boneless pork, frozen, for military procurement purposes, consists of the pork loin further processed into roasts and slices. Type I is the identification for roasts, and type II for slices. The pork loin is the only market cut that is prepared as boneless pork.

9-29. *Requirements for loins.* The fresh, chilled bone-in pork loins must be in excellent condition at the time of boning. They must show no evidence of such conditions as off-odor, slight stickiness, rancidity, sourness, or discoloration. The loins, before boning, must be full-cut, and trimming the lean from the loins to meet the weight range requirements of 12 to 20 pounds is not permitted.

9-30. The internal temperature of the bone-in loins, at the thickest part, must be between 28° F. and 40° F. from the time of initial chilling until they are boned. The maximum internal temperature at the thickest part of the chilled pork loins, after boning and until the fabricated product is placed in the freezer, cannot exceed 42° F.

9-31. The color of the bones ranges from red to dark pink, with the color of the exterior surface of the rib bones showing at least a slight red color. Cartilage must be in evidence. The split chine bones, spinous processes, and crosscut sections of bones should be porous and not brittle or flinty.

9-32. The exterior fat of the loin must be firm and white. The lean should be fine-textured and firm, with at least a slight amount of marbling in the blade and ham ends. The lean meat possesses a bright, uniform color, ranging from light pink or greyish pink to bright red, and the flesh must not be dark, gummy, or oily. Finally, the pork loins must be thick, uniformly full, and well-rounded. They should show no evidence of thawing, refreezing, or freezer burn.

9-33. The following carcass portions must be removed and excluded from loins used for both type I and type II fabricated pork:

- Flank meat, tenderloin, and blade meat (meat lying over the blade bone).
- Bone, cartilage, blood clots, bruises, semiattached fat, or tag ends
- Surface fat in excess of one-fourth inch in thickness.

Now that you have an understanding of the requirements for the pork loin, let's discuss the boneless cuts that are derived from it.

9-34. *Type I, roasts.* To preclude any possible misunderstanding, the requirements for pork roasts, fabricated (boneless), as we discuss them from here, are in addition to the requirements for the loin. First, pork roasts must be cylindrical in shape. They must be free from deep and undesirable cuts and tears. The fat surface of the trimmed loin must be on the outside of the roast. Either continuous or individual string ties are permitted to produce an intact, compact roast. It is well to mention here that Military Specification MIL-P-35098 contains the specific requirements for boneless pork roasts and slices, and includes the requirements for string-tying roasts. As in other meat products, there is a weight range requirement for type I pork roasts. They must weigh not less than 4½ pounds nor more than 10½ pounds per roast. Other requirements, such as binding agents, which apply to both type I and type II pork, will be discussed later.

9-35. *Type II, slices.* Pork loins for further processing into pork slices (type II) must meet the same requirements as for roasts (type I). The boneless fabricated loin slices should also comply with the following requirements: the slices are cut in such a way that two slices are always left attached. In other words, when the loin is sliced, only the cut between a pair (every other cut) continues completely through the meat. The alternate cuts leave each of a pair of slices well attached. The pairs of cuts can then be spread and flattened to become one slice with an area of approximately twice that of the cross section of the loin. You can make a test for intact slices by lifting the entire slice with a fork inserted at the approximate center of one of the halves (after it has been pan-fried). The two halves must remain intact as one piece. An exception is made with facing (end) slices. Because of the shape of the loin at these points, the slices may consist of one single slice rather than a pair that are half-cut.

9-36. There must be at least 75 percent of lean on each side of the two major surfaces formed by the slicing operation. At the time of slicing, the boneless pork loins must be solidly frozen to the extent that there is no soft area in the slice immediately after it is cut. Pork slices must be packed and returned to the freezer within 2 hours after being sliced. During this time, the slices must not show evidence of softness (nonfrozen areas). Each box of the packaged finished product is allowed to contain not more than 10 percent facing slices by weight. Let us now consider the qualifications that are common to both types of fabricated pork loins.

9-37. *Requirements for types I and II.* The characteristics of lean pork meat are such that a binding agent is necessary when the loin is processed into boneless roasts and slices. The purpose of the binding agent is to hold the interior surface lean together. The best time to apply the binding agent is before processing the loin into its boneless components. Military Specification MIL-P-35C98 indicates that powdered vital wheat gluten or other binding agents rendering a satisfactory finished product must be used. Whatever binding agent is used, it must conform in every respect with the provisions of the Federal Food, Drug, and Cosmetic Act and its regulations.

9-38. The blast freezers or equivalent equipment that are used to freeze fabricated pork loins must provide forced-air circulation while maintaining a freezer temperature of minus 10° F. or colder during the freezing process. The product must be properly packaged before it is placed in the freezer. The filled boxes of product should be arranged in the freezer so that for at least 24 hours the box surfaces are not in direct contact with each other. After this time, the boxes may be restacked according to convenience. The product must remain in the quick-freezing process until the temperature in the thickest part of the lean meat reaches 0° F. or colder.

9-39. Once frozen, the product must stay at a uniform temperature of 0° F. or lower. The internal temperature in the thickest part of the lean should be no higher than 0° F. at the time of shipment. Of course, it should be in excellent condition and show no evidence of thawing or refreezing when it is examined at destination.

9-40. Inspection of Fresh Pork. The contractor is responsible for inspecting the product for contract compliance. The US Government, however, reserves the right to perform any inspection necessary to assure that the product complies with the provisions of the contract. Generally, the final acceptance inspection is done at destination. If the finished product has been inspected at a point other than destination, it should then be inspected at destination for condition and identity only.

9-41. With the realization that fresh pork is very perishable, always be on the alert for signs of decomposition and spoilage. Bruises that involve lean and fat tissue are major defects. Market cuts exhibiting bruises are not acceptable on military contracts, though surface bruises that merely involve the skin are considered to be minor defects and may be accepted.

9-42. When you are inspecting pork products, you should consider certain conditions as undesirable. The presence of hair roots indicates poor workmanship in the scalding and dehairing operation. Seeds, or mammary tissue, are of three colors—white, red, and black. White seeds indicate a gilt (young female) carcass in which the mammary gland has never been active. Red seeds indicate a sow (mature female) in which the mammary gland has been active. Black seeds indicate an old sow. These seeds should be trimmed so that they are not evident. Odors not associated with fresh pork are unsatisfactory. For instance, old stags and boars (males) have a distinct odor associated with their sex, which is not acceptable. The color of fresh pork should be uniform and bright. Carcasses that are dark in color, or those with deposits of pigment on the skin surface, are rejected on procurement inspection. Scores exceeding one-half inch into the lean are not acceptable. Pork cuts should be trimmed free of frayed ends, but excessive trimming of pork cuts to comply with weight ranges is not permitted.

9-43. Surface molds are no problem, because they can be wiped off. If the mold growth is not inhibited, however, it can penetrate cracks and crevices throughout the flesh. Molds do not usually impair health, but they impart undesirable flavors to the meat.

9-44. When you are inspecting any food product, always have copies of the pertinent specifications and purchase documents at hand. Remember that for fresh pork you must use Federal Specification PP—P—00571.

9-45. Due to consumer demand, a large proportion of pork slaughtered undergoes additional processing into cured and smoked pork. The military procures large quantities of these meats. Therefore, you need a knowledge of curing agents, curing processes, and smoking techniques, which we discuss in the next section.

10. Cured and Smoked Pork

10-1. The curing process was developed long before adequate refrigeration was available in order to improve the keeping quality of the meat. The need for curing as a preserving method is greatly reduced now that the products can be satisfactorily chilled and frozen. However, the popularity of the flavors and colors of cured meat has remained. The materials used as curing agents distinctively change the flavors and colors of the treated products. Cured ham and bacon, as breakfast meats for Americans, have practically become an institution. Also, the relatively high proportion of fat and its even distribution in pork makes it an ideal meat for curing. Therefore, a large amount of pork continues to be cured.

10-2. Methods of Curing Meats. There are many methods of applying curing agents to the fresh meat. Three are considered basic: pickle curing, dry-salt curing, and dry curing. Other methods are either variations or combinations of these basic procedures.

10-3. Regardless of the curing method, the procedures must apply the fundamental principles of good sanitation and refrigeration. Good sanitary practices reduce bacterial contamination and growth. Bacterial growth is further retarded by refrigeration at low temperatures until the curing process is complete. Ideal curing temperatures are 36° F. to 38° F. Lipase, which is one of the principal causes of enzymatic rancidity, is inactivated at temperatures below 40° F. Remember, however, that reducing the temperature of the product increases the time required for the curing process.

10-4. *Pickle curing.* In pickle curing, the curing agents are first dissolved in water, and this solution is then applied to the meat. The solution formed is referred to as the pickle. If it is a simple solution of salt (NaCl) in water, it is a plain pickle. A compound pickle contains salt and water with one or more other curing agents. When sugar is added to the pickle, it is called sweet pickle. A pickle of any kind may be reused if it is properly processed. A previously used pickle is known as second pickle. It is prepared for reuse by heating it to 200° F., skimming and filtering albuminous substances from the solution, and adding curing agents to bring the pickle to the desired strength. Before it is reprocessed, second pickle that has become stringy and sticky because of bacterial action is called roppy pickle. It usually gives off a fetid odor, which may be caused by warm curing cellars, unclean vats, nonsterile pickle, and contaminated or slimy meats.

10-5. The strength of the pickle is determined by the degree of salt saturation in the water. Pure water at 60° F. weighs 8.34 pounds per gallon at sea level and will dissolve 3.03 pounds of salt. The resulting mixture, of course, makes more than a gallon of pickle. For general purposes, a saturated solution of salt in water is considered to contain 2½ pounds of salt, or 25 percent by weight. You can determine the strength of a pickle by using an instrument called a salometer. The use of the salometer is based on the principle of buoyancy. Because of the difference in buoyancy of the two fluids, a floating object will sink deeper in pure water than in a saturated solution of salt water. The salometer is a floating instrument with a calibrated stem, marked 0 at the point to which it sinks in plain water and 100 at the point it registers in a fully saturated salt solution. The space between these points is graduated in degrees. Salometers are made to read accurately in solutions between the temperatures of 35° F. and 38° F.

10-6. Even though water is completely saturated with salt, other curing agents will still dissolve in it. A 100° plain pickle will dissolve sugar and sodium nitrate as readily as pure water will. The normal amount of sugar and sodium nitrate used in the average compound pickle increases the buoyancy of the solution to the extent that the salometer reading will register about 3° higher than the actual salt concentration. Therefore, a compound pickle that measures 78° with a salometer usually is considered as a 75° salt pickle.

10-7. The required strength of the pickle varies with the purpose for which it is used. In accordance with its use, there are two kinds—curing or cover pickle and pumping pickle. Pumping pickle, which is forced into the meat, is the stronger. Although some processors use pumping pickle of 100° salt strength, a strength of 90° is more often used. Cover pickle for regular hams usually has approximately 75° to 80° salt strength. The degree of cure desired determines the strength requirements of the pickle. For military procurement, specifications are cited in the contractual documents.

10-8. As we have already implied, there are two general methods of pickle curing, covering and pumping. When the curing is to be done by covering, the meat is simply placed in vats or tierces where it is completely submerged in pickle. The extent of cure is controlled by the strength of the pickle and the length of time the meat is covered. The temperature of the meat also affects the rate of the curing action. However, the temperature is regulated to control the growth and action of undesirable bacteria rather than to control the curing process. The length of time required for this method is greater and the curing action is less evenly distributed throughout the meat than with pumping.

10-9. "Pumping" is a term that describes a means of injecting the pickle into the interior of the meat. This is done by forcing the pickle under pressure into the meat through a needle. There are two ways of pumping—the stitch or spray method, and the artery method. In the stitch method, the needles are inserted into the meat in many areas, and several strokes per area may be used. The amount of pickle injected varies from 2½ to 7 percent of the weight of the meat. This method is used to assure distribution of the curing solution in bacon and in certain areas of large hams, particularly the semitendinous and semimembranous muscles.

10-10. Artery pumping is generally used for hams. With the ham resting on a specially calibrated scale, the needle is inserted into the large artery near the aitchbone. Then pressure is used to distribute the pickle throughout the ham through the arterial system. An adequate distribution of pickle cannot be achieved with less than an 8 percent increase in the weight of the ham. The usual amounts of pickle pumped into hams are 8 to 12 percent of their weight. The practice of arterial pumping can be abused and can produce a weight increase as high as 20 to 25 percent. USDA allows an increase in weight of 10 to 12 percent if the product is returned to the green weight (fresh or uncured weight) after it is smoked.

10-11. *Dry-salt curing.* The dry-salt curing method is the simplest method used. It is referred to as country curing, for it is the one usually used in home processing. The dry salt, or a mixture of curing agents, is rubbed directly on the surface of the meat. The meat is then piled on racks or on the curing cellar floor. The curing agents extract moisture from the meat to form a brine (pickle) solution. The brine is reabsorbed into the meat by osmosis, thus starting the curing cycle. The process continues by the repeated extraction and absorption of the brine. This method is expensive and time-consuming. It is presently used in commercial curing almost exclusively for "salt pork," which is processed from large sow bellies.

10-12. *Dry curing.* The dry curing method is referred to at times as dry box cure, box cure, and dry sugar cure. After measured amounts of the curing agents are applied to the meat in dry form, the meat is stacked tightly in waterproof boxes. The lids are then closed on the slightly overfilled boxes with pressure. Under this condition, the curing process causes the meat to "stew" in its own juice. This method is considered to produce a superior or "premium" product. A variation of this method is the modified box cure. The procedures are basically the same, except that the natural liquor is tested so that identical, uniform solutions are prepared to fill each individual box or vat.

10-13. To assure that all of the cuts in a container are adequately and uniformly cured, they may need to be rearranged periodically. The meat on top of the container is placed on the bottom, the cuts on the bottom are moved to the middle, and those in the middle are relocated at the top and sides. This procedure is called overhauling. Overhauling helps prevent surface rancidity, but the practice is necessarily limited by the cost of the labor required.

10-14. Curing Trends. A wide variety of modifications and alterations in dry and box cures have been used through the years. However, most of these have been discarded with the development of new ones. The most recently adopted method is the mechanical penetration of green bellies, sometimes by injection, of the curing solution. These methods are known by various trade names such as Injecto-cure and Penetro-cure.

10-15. These newer methods allow the processor to reduce the size of his inventory and the time involved in curing. In this way, production can be increased and the costs can be reduced accordingly. There has been a trend in recent years for processors to reduce the degree and extent of curing. Therefore, the products are comparatively more perishable and have a shorter shelf-life than similar products in the past. This situation poses many problems in military supply lines if it is not recognized. You must make sure that the products furnished on military contracts are cured according to specifications.

10-16. In the past, backpacking incompletely cured cuts was practiced to retard the curing process when the supply of cured meat was greater than consumer demand. Backpacking means repacking partially cured meat in approximately 25° pickle and holding it at a temperature of 0° F. to 15° F. The use of this process has been greatly reduced because freezing has become the practical way to store green cuts. However, only the green cuts may be frozen before processing. Cured cuts are never frozen before smoking because frozen cuts lose meat juices and dehydrate too much. Limitations on the time that frozen green cuts may be held is given in the applicable specifications.

10-17. Smoking Pork. Although the smoking process does contribute to the preservation of meat, smoking is now generally applied only to cured meat. The preservative action of smoking is most concentrated on the surface of the meat. The "smudge" formed by the smoke and heat removes the moisture that encourages bacterial growth, it seals the pores, preventing bacterial penetration, and it kills approximately 90 percent of the surface bacteria. The heat involved in the process also destroys certain microorganisms within the meat. For example, the specifications require that temperatures in excess of 120° F. and 137° F. be maintained for smoking bacon and hams respectively. Even trichinae can be controlled by properly smoking hams above 137° F. With bacon, cooking is necessary to assure a trichinae-free product.

10-18. An additional preservative action produced by smoking is the production of antioxidants. These antioxidants are combustion products formed when the smoke is produced. Examples are phenols and aldehydes. They prevent oxidative rancidity when they are deposited on the surface of the meat.

10-19. *Flavor.* The flavor given the meat by the smoke is very popular with consumers, and is one of the important reasons for smoking cured meat. The kind of wood used to produce the smoke controls the flavor. The best smoke is furnished by good hardwood or hardened sawdust, with hickory the most widely used.

10-20. *Color.* As we previously mentioned, heat is needed in the color-fixing process. You will recall that this is the process where nitrates are converted to nitrites and nitric oxide myoglobin is changed to myochromogen. The heat from the smoking process, therefore, actually stabilizes the desired colors in the meat.

10-21. *Shrinkage.* The smoking process also serves to remove excess moisture that may have been introduced into the meat during the curing process. The heat should reduce the weight of the product to its original green weight or less, as designated by the applicable specifications. The extent of other shrinkage depends upon the character (fatness) of the meat, the degree of heat applied, and the length of the smoking period. The average shrinkage of pork cuts varies from 5 to 11 percent, with lean meat shrinking more than fat meat.

10-22. *Equipment.* There are four general types of smoking equipment: the stationary, rotary, forced circulation, and electrostatic types. The stationary apparatus may be a multistoried brick structure, with access for loading at each floor level, or it may have only a single floor, like the facilities of many small processors. The meat is loaded on stationary racks. The smoke is produced at the lower levels of the structure, circulating about the meat as it rises. The rotary type of equipment uses racks on endless chain drives that continually carry the meat through the smoke. The operation of forced circulation equipment is sometimes referred to as air conditioned. The smoke is circulated over the meat by time-temperature controlled fans. Electrostatic smoking equipment charges the product and the smoke particles with electrical opposites. The unlike charges attract each other, encouraging smudge development on the surface of the product.

10-23. Inspection of Cured and Smoked Pork. Remember that one of the fundamental inspection requirements is a good knowledge of the applicable specifications. In this case, MIL-H-1287, *Ham, Smoked,* and PP-B-81, *Bacon, Slab or Sliced,* are the important documents. Any additional specifications that you may need are identified in the purchase documents.

10-24. Among the common defects of smoked products are "drips," "touchers," and "drys." Drips occur when fluid or liquor from a suspended product is allowed to drop onto products hanging below it. The product that catches the dripping fluid becomes excessively sticky. Touchers can be recognized by light "bald" spots, which occur when two pieces of meat touch each other during the smoking process. Bacteria and mold can penetrate the product because of an incomplete smoked covering. Drys result when too much heat is applied during smoking, causing excessive shrinkage.

10-25. You can often detect product deficiencies that are caused by faulty curing techniques. For instance, a lack of available nitrite during the curing process produces gray or fading pink colors in the meat. If there is too much nitrite, exaggerated brown or salmon colors may be evident. Examine the products thoroughly to make sure there was complete penetration of the curing agents. If the frozen cuts are not properly thawed, incomplete penetration results. Oxidation can be detected by a greenish cast on the meat. This is produced by an enzyme called oxidase, which reacts with myochromogen. Do not confuse this green color with the normal green irridescence of refracted light from the product.

10-26. You should assure that proper temperatures have been maintained throughout the curing and smoking processes. If the temperature within hams during the smoking process fails to reach 137° F., the product can carry live trichinae. Temperatures during the curing process are also critical because they determine the time required for thorough curing.

10-27. Examine hams along the shank bones, the stifle joint, and the aitchbone (loin end). The general condition of the meat can be more certainly detected by inspection at these points. With bacon, the main inspection points are the flank pocket, featherbone line, and brisket end.

10-28. In addition to cured and smoked pork, there are many varieties of sausage procured by the military. Pork and beef are used in various combinations to produce sausages suitable to the consumer, and there is much to be discussed in the areas of processing and ingredients of sausages procured by the military.

11. Sausage

11-1. Man has developed many types of sausage to meet the temperature requirements for preservation. In southern Europe, dry sausages were developed, which would keep without refrigeration. In colder climates, fresh and semidry sausages were developed. In this country today, about 13 percent of all meat from slaughtered animals goes into sausage-making, the most profitable segment of the meat-packing industry. The various classifications, components, processing steps, and inspection of sausage will be discussed in the remainder of this section.

11-2. Classification of Sausages. The principal sausage classifications are domestic, dry, and summer, based on the way this product is processed. There are five categories of domestic sausage, and we will discuss each of them.

11-3. *Domestic sausage.* Fresh pork sausage is 100 percent pork meat except for spices. The pork is ground through a grinder, and the spices are added. If the product is to be link sausage, it is stuffed or molded into casings. This product requires refrigeration, has a limited shelf-life, and must be cooked before it is served. Examples of this product are fresh pork sausage links and pork sausage, country style.

11-4. Smoked sausage is an all-pork product with spices added. The stuffed links are smoked with hardwood until they have the appearance and flavor of a smoked product. Smoked sausage has a longer shelf-life than fresh sausage, but it must be refrigerated and must be cooked before it is served. Examples of this sausage are smoked sausage links and Polish sausage.

11-5. Smoked and cooked sausage is made of fresh beef and pork. The purchase order specifies the percentage of each of these ingredients. The meat components are mixed, ground, processed in a silent cutter, and stuffed into casings. The product is then smoked and cooked. It has a good shelf-life and is ready to eat. Examples of this type of sausage are frankfurters, bologna, and Vienna sausage.

11-6. The meat components for cooked sausage are fresh chilled pork livers, pork, and pork trimmings. Some varieties contain blood or liver. These sausages have a short shelf-life. All cooked sausage is ready to serve. Examples are liver sausage (Braunschweiger) and tongue and blood loaf.

11-7. The meat components for cooked and baked sausage are beef and pork or one of the components alone. The components are mixed and ground, processed in a silent cutter, and stuffed into pans and molds for cooking or baking. The sausage loaves are dipped in hot oil to brown and glaze. This is a ready-to-serve sausage. Examples are pickle and pimento loaf, and baked ham.

11-8. *Dry and summer sausages.* Dry and summer sausages are found on the market under a variety of names. Many varieties originated in Europe. Each country has its own meat, spice, smoke, and coloring formula. Italian sausages are very highly seasoned, while northern European sausages are heavily smoked. The meat component for dry sausage must be of high-quality. To kill trichinae, the pork used in dry sausages must be cooked to a temperature of 137° F., dried and cured in a high concentration of salt, or frozen.

11-9. After the meat is ground and the spices and curing ingredients are added, the meat for dry sausage is pressed into shallow pans. The pans are placed in a room with a temperature of 40° F. for 24 to 72 hours. This is called pan curing. The pans are removed, the meat is mixed for 2 to 3 minutes, and the product is stuffed into casings. It is then given a cold smoke, which is a dense smoke with minimum heat. After smoking, the sausage is transferred to the drying room to finish processing with controlled temperature and humidity.

11-10. Green hanging is sometimes used in lieu of pan curing and is a more critical method of curing. The sausage is stuffed into casings immediately after the grinding operation. The casings are transferred to a green hanging room where the temperature is held at 52° to 56° F. and the humidity is from 55 to 65 percent. The sausage is kept in this room for 24 to 72 hours. It is then smoked and transferred to the drying room. In this room, temperature and humidity are controlled by mechanical units that draw air through intake ducts and through a spray of water to remove dust particles and mold spores. The air is circulated over warming coils and into the drying room at a temperature of 54° to 60° F. and a humidity of 65 to 80 percent.

11-11. **Composition of Sausage.** Beef is used in sausage principally for binding. Binding refers to the cohesiveness of the sausage. The meats with the best binding qualities are hot bull beef, fresh chilled bull beef, hot lean cow beef, and fresh chilled lean cow beef. Beef adds color and flavor and improves the texture of sausage by stabilizing the fat globules. Pork contributes flavor, juiciness, and tenderness. Excessive quantities of pork produce a light color, and may yield a fat cookout or separation, and a reduced shelf-life.

11-12. Ice and water are used to control temperature during chopping. Ice water also helps to bind the product and provide a viscous emulsion to assure a smooth, even flow during the stuffing operation. An ice water and salt combination solubilizes proteins to help protect fat globules from rupturing during smoking and cooking. Salt alone acts as a curing agent and preservative. It inhibits bacterial growth and accentuates natural flavors. Spices add flavor, color, and aroma. Some contain antibiotics, other antioxidants. Sugar is sometimes added as a flavoring agent, and nitrites fix the color.

11-13. **Sausage Processing.** Sausage processing includes grinding, processing in a silent cutter, vacuumizing, stuffing, and smoking and cooking. Each step of sausage processing is important in the production of an item that is acceptable to the military service.

11-14. *Grinding.* Pork and beef are ground separately. Since pork is more tender than beef and contains a large amount of fat, it is ground only once. This eliminates the possibility of its overheating. Beef, however, is usually ground twice—first through a coarse plate, and then through a fine plate. The ground pork and beef must be weighed separately to determine the proper blend of components.

11-15. *Silent cutter processing.* After weighing, the ground meat is transferred to the silent cutter. The bowl of this cutter, which holds about 500 pounds of meat, rotates counterclockwise and carries the meat to a set of knives. These knives (from three to nine) are designed to fit the contour of the bowl and to cut through the meat at right angles to the bowl. In the silent cutter, the beef is chopped for several minutes while ice and water are added to control the temperature. This phase of processing produces a smooth, viscous mass (emulsion), which contains such soluble protein of beef as myosin and collagen. Pork is then added to the silent cutter, and it is chopped and mixed with the beef. The spices and the remaining ice and water are added to the emulsion as the chopping continues.

11-16. Chopping the pork produces tiny fat globules, which are very unstable when they are subjected to heat unless they are protected. These globules are usually protected by a covering of solubilized proteins spread throughout the emulsion. If the emulsion is chopped too much, the fat globules decrease in size and increase in number, reducing the protein coating on the individual fat globules. When this occurs, the uncoated fat separates from the meat emulsion and settles in spaces between the casing and the meat or in the end of the sausage during smoking. This produces a condition called white caps.

11-17. *Vacuumizing.* Vacuumizing is done to extract any excessive air that has resulted from the chopping in the silent cutter. It is done in a vacuum chamber or in a vacuum-mixer combination. All sausages are not vacuumized.

11-18. *Stuffing.* The stuffer is a piece of equipment used for stuffing sausages into casings. It is a large, vertical cylinder with a piston. Near the top of the stuffer are one or more outlet valves. When these valves are open, the sausage emulsion is forced through the stuffing horn into the casing.

11-19. *Smoking and cooking.* Smoking and cooking are the last step in sausage processing. The sausage is placed in the smokehouse and heat is applied. The myosin coagulates and

TABLE 11

Defects and Their Causes in Sausage

Defects	Causes
Coarse texture	Improper trim. Insufficient chopping. "Short meat" lacks binding quality.
Air pockets	No vacuum drawn. Improper filling of stuffer. Improper filling of casings. Improper air pressure. Improper size of stuffing horn.
Fading and shriveling	Improper chilling. Storing in cold draft. Storing in temperature that is too low.
Sweating and sliming	Fluctuating temperature. Storing warm product in low temperature.
Surface discoloration (greening)	Bacterial contamination after the heat process.
Internal discoloration	Bacterial contamination of raw materials before heat processing. Insufficient heat processing. Lack of nitrites.

coats and stabilizes the fat particles. Collagen, another protein, also stabilizes fat unless heat is applied too quickly or continues too long, or the smokehouse temperature is too high. Under any of these conditions, the collagen will convert to gelatin and drain away from the fat particles. This causes the fat to separate from the meat emulsion and to settle into internal pockets, or causes "fat caps" at the end of the sausage. Both collagen and myosin are capable of absorbing a considerable amount of water, but if the heat in the smokehouse or the cooker continues too long, the protein coating will shrink and the fat globules will expand and squeeze out the water. With continued heating, the protein sac ruptures and the fat separates from the meat emulsion.

11-20. Generally, frankfurters should be smoked for 1½ to 2½ hours. Larger sausages such as bologna require from 6 to 8 hours smoking time. An internal temperature for either large or small sausage should reach 155° to 160° F. before the processing is completed.

11-21. Complete processing, smoking, cooking, and chilling in a cold water shower can be done in air-conditioned smokehouses. Cooking time for small sausages is usually 10 to 15 minutes; for larger sausages, from 1 to 2 hours. After cooking, sausages must be properly chilled and adequately refrigerated to obtain maximum storage life. The average shrinkage of sausage during smoking and cooking is 6 to 8 percent. This varies according to the quality of the raw material and the processing techniques that are used.

11-22. Inspection. Five important items to check in sausage inspection are equipment, laboratory testing, raw material, workmanship, and the finished product. Sanitary inspection of plant practices, materials, and equipment is very important in the manufacture of sausage, mainly because any dirt or foreign material loses identity when it has been ground. Contaminated raw material may cause spoilage or discoloration of the finished product.

11-23. *Equipment.* You must make sure that all equipment is cleaned with hot water or steam at the end of each day's operation. At least once a week it should be sanitized with a four-tenths percent solution of sodium hypochlorite or other sanitizer after the equipment has been thoroughly cleaned with hot water or steam.

11-24. *Laboratory testing.* Specifications generally require a laboratory test for pork sausage, frankfurters, and bologna. With pork sausage, your main concern is the amount of fat it contains. Contracts generally do not allow more than 40 percent fat. However, 1 day's production may contain as much as 42 percent fat if the fat average for the total contract does not exceed 40 percent. When you receive the laboratory report, multiply the reported percentage of fat by the total number of pounds processed in that given lot to get the number of pounds of fat in the lot. Do this for each lot, and compute the total pounds of fat. Then divide this total by the total weight of the sausage produced. The result, multiplied by 100, is the total percentage of fat for the entire contract.

11-25. Frankfurters destined for oversea shipment are laboratory-tested for moisture and fat content. The maximum moisture content should not exceed 10 percent, and the fat content should not be less than 24 percent nor more than 30 percent. Frankfurters for domestic consumption are tested only for moisture. Bologna is laboratory tested for moisture.

11-26. *Raw materials and workmanship.* The meat components of all sausage must be fresh, properly refrigerated, adequately trimmed, and in the proper proportions. You must begin your inspection in the boning room. This includes inspecting the equipment and personnel. Make certain that all cuts are offered for inspection as they exist in the carcass. You must inspect each step in the process, including boning, grinding, chopping, stuffing, smoking, cooking, chilling, and packaging. Direct special attention to the contract to assure that the raw materials meet the specifications, that no prohibited meat byproducts such as salivary glands are used, and that excessive amounts of cereal fillers are not used.

11-27. *Finished product.* Table 11 summarizes defects and their causes in sausage. Sausage is examined from the exterior first. Look for "touchers"—two sausages that have touched each other, leaving an area where smoke has not penetrated. Sausages are observed for a uniform, smoked color. This includes checking for oversmoking and undersmoking. Check for green discolorations from inadequate drying, for sliminess from poor drying or poor handling in storage, and for improper or ruptured casings, air pockets, jelly pockets, and water pockets. All of these conditions are causes for rejection.

11-28. Always use a sharp knife when you are examining sausage internally in order to keep from tearing and smearing fat over the entire cut surface. Observe the uniformity of fat and lean meat and carefully note the odor and taste. Conditions that justify rejection include green centers, fat pockets, airpockets, jelly and water pockets, and the settling of fat at the end of the sausage.

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Poultry Inspection

SURVEYS REVEAL that salmonella is 12 times more prevalent in uninspected poultry. During one 10-year period, over 30 percent of the reported cases of foodborne illnesses in the United States were associated with poultry products. This not only is justification for us to inspect poultry, but also for us to acquire the knowledge which will enable us to perform these inspections properly.

2. The purpose of poultry inspection is to assure that all poultry products come from healthy birds (wholesomeness) and to determine contractual compliance. To accomplish this purpose, the inspector must have a knowledge if poultry anatomy and physiology, poultry classes and grades, and surveillance inspections. This chapter will complement the knowledge you have already acquired and, thereby, better qualify you to perform poultry inspection.

3. Before further discussion, consider the term "poultry." In its broad sense it includes many domestic birds. As you know, we are primarily concerned with chickens, so our text will concentrate in this area, with only a brief discussion of turkeys and ducks.

12. Military Procurement Classifications

12-1. The importance of poultry to the US Armed Forces is shown by the frequency with which it is included in menus. For Department of Defense procurement, poultry is classified in various ways. The initial classification deals with the species. This includes primarily chickens, turkeys, and ducks. To assure a standard product, the requirements of each species are further divided into type, style, class, and grade. Refer to figure 24, which illustrates the skeletal structure of the chicken, and keep it handy for a more complete understanding of the following discussion.

12-2. Type. Poultry types refer to their state of refrigeration:

a. Type I, fresh chilled, must be chickens maintained at 30° to 40° F.

b. Type II, frozen chickens, must be frozen not more than 60 days at 0° F. There must be no evidence of defrosting or refreezing at the time of delivery.

c. Type III, frozen chickens, may be frozen more than 60 days. Freezer storage must be limited to 120 days if the product is being procured for export, and 180 days if it is being procured for domestic purposes.

d. Type IV, frozen special chickens, are processed after the date of the contract. They must be graded before freezing. These birds are eligible for shipment to AF dining halls in Great Britain. In order for birds to be imported into Great Britain, they must meet very stringent requirements as to vaccinations, type of vaccine used, the environment they are raised in, etc. A military veterinarian must certify that they meet these requirements.

12-3. Style. Style refers to the degree of preparation for cooking or to the method of cutting up the individual birds:

a. Style 1, ready-to-cook (RTC), whole, has all inedible parts removed and the neck is cut off at the juncture with the body and placed with the giblets in the body cavity.

b. Style 2, RTC, halved (split), is prepared by making a full-length back and breast split to produce approximately equal right and left sides.

c. Style 3, RTC, quartered, is prepared as in style 2, except that it is cut (transversely) crosswise at right angles to the backbone to produce two forequarters of all white meat and two hindquaters of all dark meat. These must be of approximate equal size.

d. Style 4, RTC, cut-up, is cut into component parts: two wings, two drumsticks, two thighs, two breast halves, two back halves, and one neck with giblets. These component parts

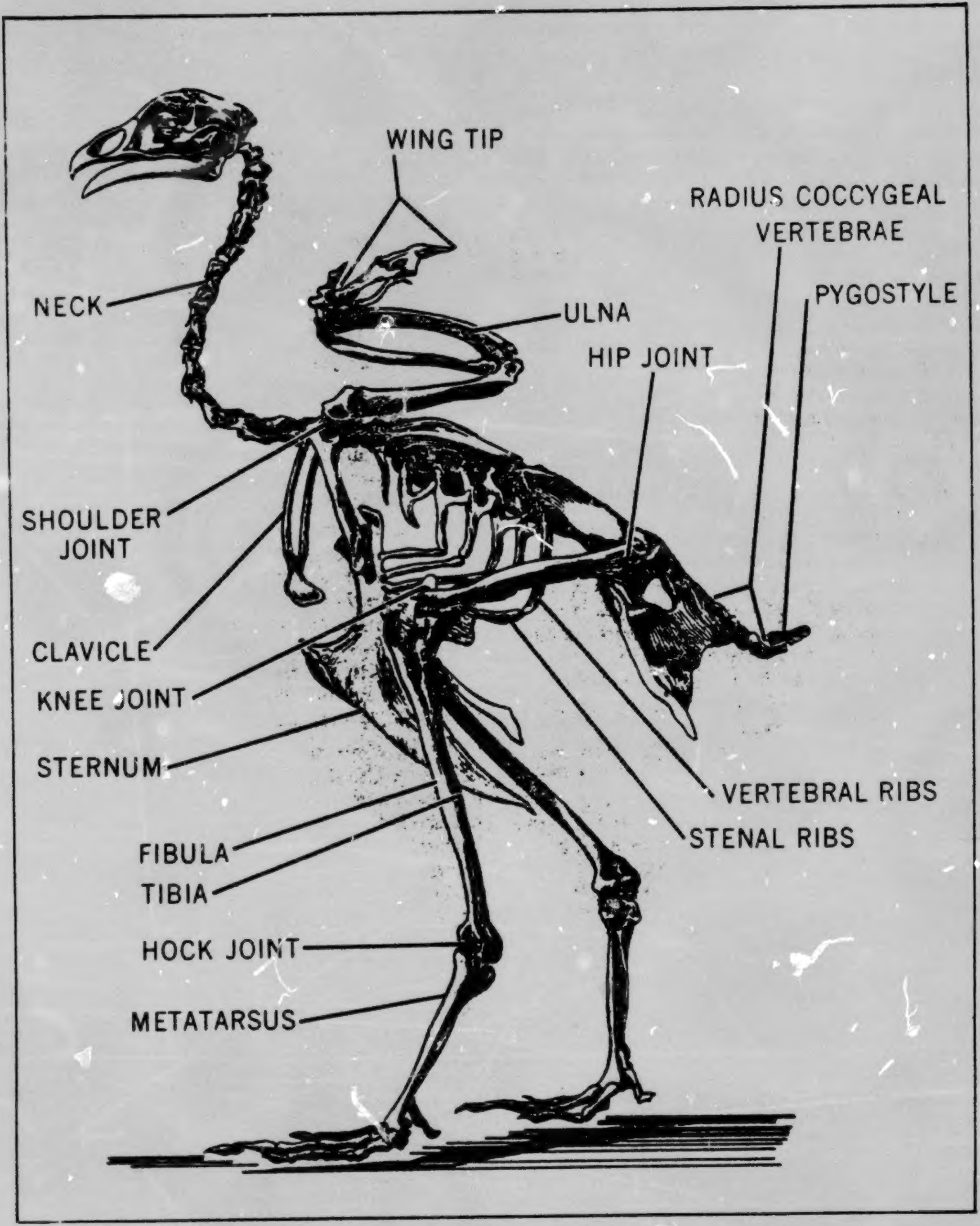
WING TIP
RADIUS COCCYGEAL VERTEBRAE
PYGOSTYLE
NECK
ULNA
HIP JOINT
SHOULDER JOINT
CLAVICLE
KNEE JOINT
STERNUM
VERTEBRAL RIBS
STENAL RIBS
FIBULA
TIBIA
HOCK JOINT
METATARSUS

Figure 24. Skeletal structure of the chicken.

are packed in the same proportionate number in which they occur on the carcass.

e. Style 5, RTC, parts, is cut as specified in style 4 to yield the following parts: wings, legs (drumstick and thigh intact), breasts, backs, necks, gizzards, hearts, and livers.

12-3. Class B. Poultry classes are based on three characteristics: age, weight, and sex.

12-5. *Age*. Age is determined by the flexibility of the breastbone. As a bird ages, the cartilage on the tip of the breastbone gradually hardens and becomes firm and rigid.

Young birds are usually more rangy, and the color and texture of their meat is light and soft. As a bird grows older, it becomes more blocky, and the meat becomes darker and tougher. Fat is more evenly distributed in young birds; in older birds, it is patchy.

12-6. *Weight*. Weight is specified in each class of poultry, with minimum and maximum weight ranges stated in the specifications. Normally, the Armed Forces do not procure the full range of weights for each class listed in the specification. For example, ready-to-cook fryers usually weigh from 2 to 2¾ pounds when they are procured. Fowl is usually procured at a weight range of 3 to 5 pounds.

12-7. *Sex*. Sex characteristics in live birds are the size, shape, and development of the head, comb and wattles, feathering, and spur development. However, after a bird is dressed and eviscerated, a much closer study of the body, skin, keel, and legs must be made to accurately determine its sex.

12-8. The male body is generally larger and more angular than that of the female. The depth from the keel to the back is greater, and the bones are longer, larger, and coarser. The female is fine-boned and the body is more round. In the male, the back is flat and box-shaped. In the hen, it is more definitely rounded from side to side.

12-9. The skin of the male is coarser, particularly in older birds. The feather follicles are larger, and there is less fat under the skin in the heavy feather tracts. In older fowl, the fat becomes patchy, and excessive abdominal fat is common in heavyweight fowl.

12-10. The drumstick and thigh of the male are relatively long, with the flesh tending to show less fullness until maturity is reached. The drumstick and thigh of the female are short, and the drumstick tends to be round.

12-11. The classes of chickens are as follows:

a. Class I, broiler-fryers: young birds 9 to 12 weeks old of either sex.

b. Class II, roasters: young birds usually 3 to 5 months old, of either sex.

c. Class III, capons: surgically castrated male chickens.

d. Class IV, stags: male chickens that have not attained full maturity, with coarse skin, somewhat toughened and darkened flesh, and considerable hardening of the breastbone cartilage. Maturity intermediate between that of a roaster and a cock, or old rooster.

e. Class V, fowl: a hen or stewing chicken that is a mature female.

f. Class VI, cocks: old males (roosters) that have usually been used for breeding.

g. Class VII, rock cornish game hen.

12-12. **Poultry Grading.** In Federal poultry inspection, there are two terms that you must understand:

a. "US Inspected for Wholesomeness." This term indicates that the product is acceptable *only* from the standpoint of plant sanitation and product soundness.

b. "US Grade _____.' This term indicates that the quality of the product has been examined in accordance with Federal grade standards and has been placed in a specific quality category.

12-13. In plants under Federal inspection, *all* birds *must* be "US Inspected for Wholesomeness," but the plant has an option as to whether all, some, or none of its products will be "US Graded." Your first concern in the grading of poultry is the document that describes the specific limitations for the various factors to be considered. This is the Federal grade standards, mentioned above, which is entitled *Regulations Governing the Grading and Inspection of Poultry and Edible Products Thereof and United States Classes, Standards, and Grades with Respect Thereto*. Grade requirements may also be specified in the contract applicable to the particular purchase.

12-14. The determination of the quality (grade) of dressed and ready-to-cook poultry can be compared to the quality determination of shell eggs. No individual bird can grade higher than its lowest individual grading factor. For example, a bird may be of A quality in all aspects except for one quality grading factor. If this factor is B quality, the final classification of the bird is B quality. Differentiating between borderline cases (whether A or B quality) is often difficult and usually results in a grade based solely on the personal opinion of the grader. Refer to table 12 as you consider the following factors (extracted from the USDA Poultry Grading Standards), which are used in determining quality grades for poultry.

12-15. *Conformation*. This refers to the general outline or shape of the bird and is based primarily on its skeletal structure.

12-16. *Fleshing*. Fleshing refers to the amount and distribution of flesh on the bird, particularly on the drumsticks, thighs, and breast. When you are determining this factor, keep in mind the age and species of the bird because the degree of fleshing varies accordingly.

12-17. *Fat covering*. Fat covering is an important grading factor and should be

TABLE 12

Summary of Specifications for Standards of Quality for Individual Carcasses of Ready-to-Cook Poultry and Parts Therefrom

FACTOR		A QUALITY			B QUALITY			C QUALITY
CONFORMATION:		Normal			Moderate deformities			Abnormal
Breastbone		Slight curve or dent			Moderately dented, curved, or crooked			Seriously curved or crooked
Back		Normal (except slight curve)			Moderately crooked			Seriously crooked
Legs and Wings		Normal			Moderately misshapen			Misshapen
FLESHING:		Well fleshed, moderately long, deep and rounded breast			Moderately fleshed, considering kind, class, and part			Poorly fleshed
FAT COVERING:		Well covered --especially between heavy feather tracts on breast and considering kind, class, and part			Sufficient fat on breast and legs to prevent distinct appearance of flesh through the skin			Lacking in fat covering over all parts of carcass
PINFEATHERS:								
Nonprotruding pins and hair		Free			Few scattered			Scattering
Protruding pins		Free			Free			Free
EXPOSED FLESH:[1] Carcass Weight		Breast and Legs	Elsewhere	Part	Breast and Legs[2]	Elsewhere[2]	Part	
Minimum	Maximum							
None	1½ lb.	None	3/4"	(Slight trim on edge)	3/4"	1 1/2"	(Moderate amount of the flesh normally covered)	No Limit
Over 1½ lb.	6 lb.	None	1 1/2"		1 1/2"	3"		
Over 6 lb.	16 lb.	None	2"		2"	4"		
Over 16 lb.	None	None	3"		3"	5"		
DISCOLORATIONS:[3]								
None	1½ lb.	1/2"	1"	1/4"	1"	2"	1/2"	No Limit[4]
Over 1½ lb.	6 lb.	1"	2"	1/4"	2"	3"	1"	
Over 6 lb.	16 lb.	1 1/2"	2 1/2"	1/2"	2 1/2"	4"	1 1/2"	
Over 16 lb.	None	2"	3"	1/2"	3"	5"	1 1/2"	
Disjointed bones		1			2 disjointed and no broken or			No limit
Broken bones		None			1 disjointed and 1 nonprotruding broken			No limit
Missing parts		Wing tips and tail[5]			Wing tips, 2nd wing joint, and tail			Wing tips, wings, and tail
FREEZING DEFECTS: (When consumer packaged)		Slight darkening over the back and drumsticks. Few small 1/8" pockmarks for poultry weighing 6 lb. or less and 1/4" pockmarks for poultry weighing more than 6 lb. Occasional small areas showing layer of clear or pinkish ice.			Moderate dried areas not in excess of 1/2" in diameter. May lack brightness. Moderate areas showing layer of clear, pinkish, or reddish colored ice.			Numerous pockmarks and large dried areas.

[1] Total aggregate area of flesh exposed by all cuts and tears and missing skin.

[2] A carcass meeting the requirements of A quality for fleshing may be trimmed to remove skin and flesh defects, provided that no more than one-third of the flesh is exposed on any part and the meat yield is not appreciably affected.

[3] Flesh bruises and discolorations such as "blue back" are not permitted on breast and legs of A quality birds. Not more than one-half of total aggregate area of discolorations may be due to flesh bruises or "blue back" (when permitted), and skin bruises in any combination.

[4] No limit on size and number of areas of discoloration and flesh bruises if such areas do not render any part of the carcass unfit for food.

[5] In geese, the parts of the wing beyond the second joint may be removed, if removed at the joint and both wings are so treated.

sufficient to mask the color of the flesh beneath. As with fleshing, the inexperienced grader is often too critical on this factor when he is grading young birds that have not yet added a good covering of fat.

12-18. *Pinfeathers.* There are two types of pinfeathers considered in grading poultry: protruding and nonprotruding. Protruding pinfeathers have penetrated through the skin, but have not necessarily formed a "brush." You can insert your fingernail under the ends of such pinfeathers. Nonprotruding pinfeathers can be seen, but they have not pushed their way through the outer layer of skin. When grading dressed poultry, you must consider both the number and location of both types of pinfeathers. A bird is considered free of protruding pinfeathers if it has a generally clean appearance (especially on the breast), and if no more than an occasional protruding pinfeather is in evidence during a more careful examination.

12-19. *Vestigial feathers.* These are rudimentary structures. There are two types of vestigial (imperfectly developed) feathers—hair easily removed by singeing and down (small silky feathers with no web, lying between the main feather lines). Down is very common on ducks and geese, and is often seen on fryers. It is difficult to remove, and when it is wet it clings to the skin and cannot be easily seen nor removed by singeing. All Grade A poultry must be free of vestigial feathers (both hair and down), and protruding and nonprotruding pinfeathers.

12-20. *Cuts, tears, and missing skin.* Cuts, tears, and missing skin detract from the appearance of the bird, permit the flesh to dry out when the bird is cooked (thus lowering its eating quality), and expose the flesh to dehydration in storage. The number and extent of these defects that are permitted depend upon their location. If the defects are on the breast or legs, less tolerance is permitted because these are the most valuable parts. Sewn tears are not allowed in any acceptable bird.

12-21. *Discoloration.* Discoloration factors involve the color, the type, and the size of the discoloration. Certain varieties of chickens and turkeys have a normal bluish-green color and a brownish-black pigment, melanin, in the feather follicles in the abdominal area. Even such natural discoloration should be considered as part of the total area of discoloration.

12-22. Skin bruises can be distinguished from flesh bruises when you move the skin. Bruises must be removed before grading, and the resulting cut is considered along with other cuts and tears. Consider all discoloration defects to determine the total area involved. Discolorations on the breasts and legs are not as tolerable as those on other parts of the body, however.

12-23. *Broken or disjointed bones and missing parts.* The number of broken or disjointed bones and missing parts varies with the grade, as indicated in table 12. There must be no related bruise or blood clot. Some parts of the bird may be removed without affecting the grade, namely, the pygostyle (free part of the tail) and the tips of the wings. Carcasses to be used for cut-up styles can have any number of parts removed for any reason whatever. Cartilage separated from the breastbone is not considered a disjointed or broken bone.

12-24. After evaluating all quality factors independently, grade the bird on the basis of the *lowest* factor present. Poultry should be graded no higher than the lowest factor according to table 12. Carcasses with defective parts may be graded after the defective parts have been removed. The removal of defective parts does not affect the grade of the rest of the carcass, provided the remaining portion is to be used as cut-up chicken parts in the official establishment where the chicken is graded.

12-25. The inspection procedure for poultry is comparable to that of any product procured by the military. The specification requirements for type, style, and class, as previously discussed, must be examined. The Federal grade standards will also be involved in verifying the grade of poultry procured. The responsibility and procedure for poultry inspection will be described in the next section to bring all of these requirements into perspective.

13. Destination and Surveillance Inspections

13-1. Destination inspection is the inspection of poultry at its destination for the purpose of final acceptance. Surveillance inspection means the inspection of Government-owned poultry, and includes inspecting the product in storage. We will start with your responsibilities at destination, then consider the elements of surveillance inspection.

13-2. **Destination Inspection.** Normally, destination inspection includes determination of condition, identity, piece-count, net weight, and temperature. If you encounter evidence of fraud or substitution, you should not hesitate to recommend provisional rejection.

13-3. The following problem situation is to get you "into the act." (We will not concern ourselves with the mechanics of verification inspection because it has already been discussed in Volume 1.) In this example, we will concentrate on what your responsibilities are at destination. The knowledge you gain in overall procurement inspections will aid you in performing the various duties of destination inspections. Here is the situation.

13-4. *Problem situation.* You are assigned to the base cold storage facility where a 30,000-pound shipment of chicken is received. According to the purchasing document, the chickens are to be US Grade A, type II, class I, style 1. The authorized weight range is 2 to 2¾ pounds per carcass. The total number of wirebound wooden boxes in the shipment is 480. The contract specifies that the "acceptance point" is destination. How would you conduct the inspection?

13-5. Write your solution, in detail, starting with the inspection of the carrier, and then compare your answer to the one that follows. If portions of the given solution are not clear to you, or if you disagree with them, talk them over with your trainer or supervisor.

13-6. *Solution to problem situation.* To inspect this product properly, you must first establish what is meant by type II, class I, style 1 poultry. With this established, and all pertinent documents (contracts, specifications, clauses, articles, etc.) in hand, you are ready to go to work. As the truck arrives, place thermometers in with the load (when applicable), insert others in some of the chickens, and close the doors. After waiting a few minutes (not more than 5 minutes), open the doors, read the thermometers, and average the temperatures. As you place the thermometers in the carrier, check for off-odor and filth. With everything satisfactory thus far, and with the understanding that sample cases for inspection will be selected after the truck is off-loaded, begin the unloading. During off-loading, keep an eye out for possible damage that you may have missed while the product was on the carrier. Also, examine the box markings for contract compliance.

13-7. When off-loading is complete, select sample boxes at random and have them moved to the inspection room, where you examine the birds in each box for identity, condition, count, and weight. To do this properly, each sample box must be emptied and examined separately.

13-8. Poultry is usually packed in wirebound wooden boxes. Since this type of box varies in weight, you must weigh each box individually to establish the tare weight. It is a good idea to record the tare weight on the top of the box with a crayon or pencil. When poultry is being packed for oversea shipment, box liners are required. They should be U-liners, which overlap 4 inches on the top and 2 inches on the sides (one U-liner covers the bottom, ends, and top; another covers the bottom, sides, and top). Other types of box liners are acceptable if stipulated in the current contract.

13-9. As you open the sample boxes, examine the exposed surfaces of the top layer, and make sure that each bird is tightly wrapped in wet waxed paper (or other authorized material). This is important because torn and loose wrappers expose the carcasses to freezer burn. After removing the first layer of birds from the box, examine the bottom (second) layer as you did the top layer. Chickens are usually packed in double rows, two layers deep, with the breast up and the shanks toward the center of the box. (You should be well versed in the mechanics of determining net weights at this stage in your career as a veterinary specialist, so no time will be devoted to a discussion of this operation in this text.)

13-10. You realize, of course, that frozen poultry must be thawed before it can be properly graded. Note also that an understandable mistake is provisional rejection of poultry for short weight, because you forgot to weigh the giblets. Don't let this happen to you. The weight of the carcass includes the giblets.

13-11. The giblets in the sample cases (one liver, gizzard, and heart per bird), together with the neck, should be wrapped in authorized paper and placed in the body cavity. It is permissible to remove some or all of the skin from the necks, but they must be clean. The livers should be firm and not torn or mashed, and the gizzards and hearts should be properly trimmed. In the process of examining the giblets of each individual bird in the sample lot, place the bird (with giblets) on a scale and determine that it is within the 2- to 2¾-pound weight range. Be constantly on the lookout for excessive amounts of water and ice throughout the entire inspection, particularly when you are determining the weights of both the individual birds and the cases of birds. As economical as poultry is, it can be quite expensive if you purchase excessive amounts of ice and water with it.

13-12. An inspection is not really complete until the lot is repacked and properly stored. You can do this best by repacking and placing each case in the cooler or freezer after you have examined it and before you inspect the next sample case. If thawing is necessary or takes place during the inspection, the birds should *not be refrozen.* During the examination, be careful in removing the wrappers to keep from tearing them. Take the same care in rewrapping the chickens for repacking, to minimize, if not eliminate, freezer burn while the product is in cold storage.

13-13. Did you include all of the major steps in your solution? Your personal system of inspection should at the least encompass the areas we have just discussed.

13-14. **Surveillance Inspection.** Our

discussion thus far has concentrated on inspecting the product before final acceptance. Now you are inspecting poultry that is already Government-owned, including poultry in storage.

13-15. For the moment, we will leave the products in storage and discuss the surveillance inspection that pertains to shipping and receiving. Since we are concerned with birds that are Government-owned but still must be transported, keeping them fit for use as human food becomes our main interest. As you may realize, this type of inspection involves more than the product itself.

13-16. The temperature of the vehicle transporting the product should be checked. In addition, this vehicle should be inspected for cleanliness and freedom from objectionable odors. Cleanliness and freedom from objectionable odors are extremely important. Dirt and objectionable odors can contaminate the product sufficiently to render it undesirable for consumption.

13-17. To inspect the birds, open the boxes of your sample lot, and unwrap and inspect at least two birds from each box. Note their condition, especially the degree of freezer burn, if present. Rewrap the birds, place them back in the boxes, and close the boxes.

13-18. Poultry in storage is frozen at a temperature of 0° F. or lower. Poultry, like other stored products, should be inspected every 30 days to ascertain its current condition and anticipated storage life. You routinely inspect 5 percent of the total number of birds stored. If your inspection of this 5 percent reveals a breakdown in the product, more must be inspected. If there are any findings that indicate breakdown, recommend immediate use of the product, if possible. Such breakdowns may include,but are not necessarily limited to, the following conditions:

a. Slime and/or mold. If it is not too extensive, slime and mold can be washed off with a solution of salt water or soda water.

b. Greening. Greening, also known as green struck, is not considered a health hazard, but is objectionable because it leaves poultry visually unappetizing. Birds in this condition are rejected because of their appearance; however, the unaffected parts of the carcass may be retained.

c. Giblet decomposition. Giblets have a maximum storage life of only 9 to 10 months and should be watched closely. This is especially true of the liver.

d. Freezer burn. Freezer burn is caused by air seeking to saturate itself with moisture. Maintaining a constant temperature is an important factor in preventing deterioration of stored poultry. Also, poultry should be properly wrapped to maintain good storage life.

13-19. Freezer burn is actually localized dehydration. You, as the inspector, should remember that boxes on the top and sides of the lots in storage are exposed to more air currents and will show more freezer burn than boxes in the center of the stack. The samples you select for in-storage inspection should come from the areas of the lot that are most likely to be affected by freezer burn or deterioration. If you detect any deterioration, draw representative samples from the entire lot to obtain a truer picture of the percentage of the lot showing deterioration.

13-20. If you have not already been involved in surveillance inspection of poultry, you most assuredly will. Whether your responsibilities involve inspecting Government-owned poultry before shipment, upon receipt, or in storage, your goal should be the same: to assure that the product is maintained in a wholesome state until it is consumed.

14. Turkeys and Ducks

14-1. The procedures and requirements for the inspection of turkeys and ducks are similar to those for chickens. Therefore, as we mentioned in the introduction to this chapter, we will discuss the inspection of turkeys and ducks only briefly, presenting the procedures and principles that differ from those for chickens.

14-2. Turkeys. Current specifications state that the "types" of turkeys are exactly the same as for chickens, but the classes are somewhat different and are listed in the USDA regulations as follows:

a. Class I, fryers-roasters: young (usually 16 weeks old) immature turkeys of either sex.

b. Class II, young hens: young (usually 5 to 7 months old) hens.

c. Class III, young toms: young (usually 5 to 7 months old) male turkeys.

d. Class IV, yearling hens: fully matured (usually under 15 months old) hens.

e. Class V, yearling toms: fully matured (usually under 15 months old) male turkeys.

f. Class VI, old turkeys: mature or old turkeys (usually over 15 months old) of either sex.

14-3. Since we have already explained the "styles" of poultry (chickens), it should suffice to state that the styles of turkeys are:

- Style 1, RTC, whole.
- Style 2, RTC, halved (split).
- Style 3, RTC, quartered.
- Style 4, RTC, cut-up.

14-4. Turkey grades correspond generally to those for chickens. Grading factors are the same except that more tolerance is allowed for turkeys because of their larger size. You should already be familiar with grading standards after having studied lable 12. Turkey packing and packaging are much the same as for chickens, with an exception in the placing of the giblets.

14-5. Giblets may be placed in one of two places. The wrapped giblets and unwrapped neck may be placed either in the body cavity, or under the skin in front of the breast in the region of the crop. This gives the bird a more plump appearance and makes it more appealing to the buyer. The second method is wrapping and packing them in the same way as chicken giblets.

14-6. Turkeys are packed in solid fiberboard cases, or in wirebound or nailed wooden boxes. Of course, these boxes are larger than those for chickens, with 30 by 22 by 8½ inches the maximum size. The maximum allowable weight per box is 115 pounds. The boxes packed for export are strapped or banded.

14-7. Ducks. There are four duck types lised in current specifications:

a. Type I birds are fresh chilled and processed under continuous Government inspection.

b. Type II birds are solidly frozen for less than 60 days and are processed under continuous Government inspection.

c. Type III birds may be frozen more than 60 days and are processed and frozen in the same way as type II. Their freezer storage time is limited to 120 days when they are procured for domestic shipment.

d. Type IV frozen special birds are processed and frozen under continuous Government inspection after the date of the contract. Grading is done before freezing, and grade tolerances do not apply.

14-8. As duck types differ from those of turkeys and chickens, so do the classes and styles. There are three classes:

a. Class I, broiler or fryer ducklings: young ducks, usually under 8 weeks old, of either sex.

b. Class II, roaster ducklings: young ducks, usually under 16 weeks old, of either sex.

c. Class III, mature or old ducks: usually over 6 months old, of either sex.

14-9. Styles of ducks differ from those of other poultry simply because there are relatively fewer of them. Chickens have five styles and turkeys four, but ducks have only three. These three styles of ducks are:

- Style 1, RTC, whole.
- Style 2, RTC, halved (split).
- Style 3, RTC, quartered.

14-10. The quality factors are exactly the same as for chickens. Grading and inspection are also the same. When you are grading ducks and looking for defects, such as pinfeathers or cuts and tears, you should use the same standards as you use for grading chickens.

14-11. The purchase of ducks for troop feeding is uncommon. They are primarily procured by the commissary for resale. Packaging, packing, and marking requirements should be in accordance with the purchasing document, and the current specifications and clauses that apply.

14-12. Regardless of the product, whether it is duck, turkey, or chicken, processing of the product is undercut if the processing establishment, its equipment, and facilities are not constructed, maintained, and operated in a clean, sanitary manner. Further, you must always remember that all poultry products must originate from establishments operating under the supervision of the USDA, or in state-inspected plants that have been "certified" in accordance with the Wholesome Poultry Product Act.

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ECI Form No. 17

STUDY REFERENCE GUIDE

1. *Use this Guide as a Study Aid.* It emphasizes all important study areas of this volume. Use the Guide for review before you take the closed-book Course Examination.

2. *Use the Guide for Follow-up after you complete the Course Examination.* The CE results will be sent to you on a postcard, which will indicate "Satisfactory" or "Unsatisfactory" completion. The card will list *Guide Numbers* relating to the items missed. Locate these numbers in the Guide and draw a line under the Guide Number, topic, and reference. Review these areas to insure your mastery of the course.

Guide Number	*Guide Numbers 300 through 312*
300	Introduction to Anatomy of Food Animals; Skeletal and Muscular Anatomy; pages 1-5
301	Nervous, Digestive, Circulatory, Lymphatic, Respiratory, and Urogenital Systems; pages 6-8
302	Introduction to Beef Inspection; Beef Processing; pages 9-15
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305	Introduction to Veal, Lamb, Pork, and Sausage Inspection; Veal and Calf (Chilled or Frozen); pages 31-34
306	Lamb; pages 34-39
307	Pork; pages 39-47
308	Cured and Smoked Pork; pages 47-50
309	Sausage; pages 50-53
310	Introduction to Poultry Inspection; Military Procurement Classifications; pages 54-58
311	Destination and Surveillance Inspections; pages 58-60
312	Turkeys and Ducks; pages 60-61

CHAPTER REVIEW EXERCISES

The following exercises are study aids. Write your answers in pencil in the space provided after each exercise. Immediately after completing each set of exercises, check your responses against the answers for that set. Do not submit your answers to ECI for grading.

CHAPTER 1

Objective: To show knowledge of the skeletal and muscular anatomy of beef, lamb, veal, and pork; and to identify their accessory organs.

1. What Federal agency is responsible for the antemortem and postmortem inspection of meat procured by the military? (Intro.-1)

2. What are the smallest units of an animal's body? (1-1)

3. Give three examples of epithelial cells. (1-3)

4. What cells hold other specialized cells together to form tissue and organs? (1-4)

5. What areas of the body does the peripheral nerve system supply? (1-7)

6. Explain the difference between the mucous membranes and the serous membranes. (1-9)

7. What are the three major subdivisions of the skeletal system? (1-11)

8. List the vertebrae of the bovine. (1-13)

9. Which vertebrae do the ribs articulate with? (1-15)

10. What is the difference between a young animal's and an old animal's sternum? (1-16)

11. What group of bones in the bovine skeletal system is comparable to the bones in the wrist of man? (1-18)

12. When a bovine carcass is split in the middle, the symphysis pubis is exposed. What is this bone called? (1-20)

13. What type of joint is formed between the radius and carpus of a cow? (1-21; Fig. 1)

14. If you were to examine a voluntary muscle under a microscope, what would the muscle look like? (1-23)

15. What is one of the more important muscles to consider when determining the condition of beef? (1-25)

16. The nervous system is divided into what two systems? (2-2)

17. Within what nervous system would you find the spinal cord? (2-3)

18. What is the function of the chemical reactions in the digestive system? (2-6)

19. Where are the three major salivary glands located in the bovine? (2-8)

20. Name the four compartments of the bovine stomach. (2-9)

21. What is the main function of the pancreatic juices? (2-12)

22. What is the fibrous tissue that surrounds the heart called? (2-13)

23. What are the main functions of the lymph system? (2-16)

24. Why is examination of the lymph nodes (glands) highly important when you are inspecting animals that are being processed for food? (2-18)

25. Name the main parts of the respiratory system. (2-19)

26. List four principal parts of the urinary tract. (2-21)

CHAPTER 2

Objective: To show an understanding of the processing, grading, and inspection of carcass beef; to demonstrate knowledge of the production and inspection of fabricated beef.

1. What publication is the guideline for all USDA inspection of meat and meat products? (Intro.-2)

2. What publication governs the sanitary requirements for meat processing plants in overseas areas? (Intro.-3)

3. What does the term "evisceration" mean? (3-1)

4. List three advantages of shrouding beef. (3-3)

5. Assume: (a) chilling time of 18 hours; (b) size of beef sides, average; (c) salt water shroud; (d) cooler temperature, 34° F.; (e) cooler doors kept closed; (f) sides cooled to 38° F.; (g) sides placed so that there was maximum air circulation; and (h) humidity of box, 95 percent. Describe the condition of the carcasses removed from the cooler. (3-3-5)

6. What would you classify beef that is produced from a female bovine which has not attained full sexual maturity? (3-8)

7. List the five anatomical sex determination factors. (3-9)

8. What shape is the gracilis muscle in female bovines? (3-12)

9. List the five styles of beef. (3-14)

10. How many ribs remain on the hindquarters of a beef carcass that has been ribbed into Style I beef? How many remain on both forequarters? (3-15)

11. Describe Style IV beef. Where is it located on a carcass? (3-18)

12. What wholesale beef cuts make up the "back"? (3-20)

13. Describe a square-cut chuck. (3-22)

14. Describe the brisket. (3-24)

15. Describe the location of the short plate. (3-25)

16. Describe the round, primal. (3-27)

17. Where is the short loin, regular, separated from the sirloin? (3-29, 30)

18. You are inspecting a wholesale market cut at destination and find that it has been excessively trimmed to meet a specified weight range. What would you do with this piece of meat? (3-32)

19. List four characteristics that are required of fresh chilled or frozen beef. (3-33)

20. When preparing beef quarters for shipment on a contract specifying destination inspection only, what additional marking is the contractor required to make? (3-36[illegible]

21. Who originates the standards for grades of carcass beef? (4-1)

22. List the USDA grades of beef. (4-4)

23. Name the two factors which collectively establish the quality (appearance, taste, and tenderness) of meat and help establish the quality grade of cuts. (4-5)

24. In evaluating various cuts of a beef carcass to establish overall conformation, what are the two prime consideration factors? (4-7)

25. How is the age of a carcass determined? (4-10)

26. What is "marbling"? Why is it important in a beef carcass? (4-11)

27. What color is the most desirable for a cut of fresh beef? (4-13)

28. What quality grades are applied to beef from bulls and stags as well as steers, heifers, and cows? (4-15)

29. What designated grade of stag beef is comparable in quality to a similarly designated grade of beef derived from steers? (4-18)

30. What grade would you apply to a bull beef carcass which has the following characteristics: (4-20)

   a. No visible finish.
   b. Thin rounds and chucks.
   c. Thin and sunken loins and ribs.
   d. Soft, dark flesh.
   e. No interior or exterior fat.

31. What characteristics of quality and conformation would you expect to find when inspecting a choice grade stag carcass? (4-22)

32. You are to rib a side of beef in order to determine its palatability grade: (4-24)

   a. How many cuts are made to partially separate hindquarter and forequarter and thus reveal the ribeye muscle?
   b. Briefly describe where and how the cut (s) is made.

33. What two limitations are placed on allowing superior conformation to compensate for deficiencies in quality when grading beef? (4-26)

34. Summarize in one sentence the relationship of conformation and quality in establishing the final quality grade of a carcass or wholesale cut. (4-28)

35. State the four considerations (variable factors) that are used to determine the cutability grade of beef and tell how each factor is expressed in computations. (4-30)

36. When determining the cutability of a beef carcass, how is the percent of kidney, pelvic, and heart fat evaluated? (4-32)

37. To what extent would a difference of 3 square inches in ribeye area affect the cutability grade of a beef carcass? (4-34)

38. When is it necessary to make adjustments in the measurements of variable factors (considerations) before inserting them into a formula to determine the cutability grade of beef? (4-36)

39. If you must adjust the chilled carcass weight to hot carcass weight, what numerical calculations must be made? (4-38)

40. Explain this formula: (In terms of constants and variables): (4-40)

Cutability group $= 2.50 + 2.50T + 0.20P + 0.0038W - 0.32A$

41. Given a 490-pound chilled carcass which has one-half inch of fat over the ribeye; 10½ square inches of ribeye; and 3½ percent of its weight in kidney, pelvic, and heart fat, determine its cutability group. (4-41)

42. What is the standard percentage used for kidney, pelvic, and heart fat when determining the cutability grade for a trimmed forequarter from a USDA grade "Good" carcass? (4-43)

43. Given a prime grade 20-pound chilled short loin, trimmed, with fat over the ribeye of 0.8 inch and an area of ribeye of 14.1 square inches, determine the cutability group. (4-46)

44. What are the three surveillance points (time or place) for chilled, fresh beef? (5-1)

45. When performing a surveillance inspection, what are the three indicators that alert the beef inspector to a lack of wholesomeness and soundness? (5-2)

46. Why is the hanging tender an area where slime may form on a beef carcass? (5-5)

47. Why is the jugular furrow an area for rapid spoilage? (5-6)

48. How would you make an inspection to detect a sour-round condition in beef? (5-9)

49. Where on a beef carcass would you observe the "eye of beef"? (5-11)

50. If you were to find evidence of off-condition or a latent defect while inspecting Government-owned carcass beef, what would your course of action be? (5-12)

51. What steps should you take when inspecting the vehicle that delivers carcass beef? (5-14)

52. When you perform a surveillance inspection of beef in storage, what are the two things which you should be concerned? (5-15)

53. Define "type" and "style" as it applies to fat beef. (6-2)

54. List the different styles found in type I, oven roast. (6-4)

55. Why are grill steaks so expensive in price? (6-6)

56. Describe the process whereby type IIIA, grill steaks (formed), are molded into shape. (6-8)

57. What beef cuts are used in the production of type V, swiss steaks (regular)? (6-11)

58. What are the weight limits for each piece of swiss steak? (6-12)

59. What is the main difference between type V, swiss steak, and type VI, minute steak? (6-14)

60. Can two pieces of minute steaks be knitted together? (6-16)

61. What is the maximum amount of external fat that any fab beef cut may have? (6-18)

62. What quality grade and class must be used for the production of ground beef? (6-21)

63. What is the maximum amount of fat allowed in ground beef procured by the military? (6-22)

64. What are the cuts that may be used in the production of diced beef? (6-25)

65. In accordance with the quality assurance provisions of Military Specification MIL-B-43813, the supplier (contractor) is responsible for performing all required inspections of boneless beef. What right to perform inspections is reserved by the US Government? (6-27)

66. What labeling and marking of individually wrapped or packaged fab beef cuts are required? (6-29)

67. Where should the category identification be placed on a box of fab beef? (6-30)

CHAPTER 3

Objective: To show knowledge of veal, lamb, pork, and sausage processing, including types, styles, and wholesale cuts, grades and grading factors, carcass inspection, and fabricated veal and lamb processing and storage procedure; the processing of boneless pork; and the methods, processing, and inspection of cured and smoked pork and sausage.

1. From what animal is veal obtained? (Intro.-1)

2. Most of the sheep marketed for slaughter in the United States are of what age? (Intro.-2)

3. What is sausage? (Intro.-4)

4. What is a "vealer"? (7-1)

5. What advantage is realized from cold skinning of veal? (7-3)

6. Upon what is the differentiation between veal and calf carcasses primarily based? (7-6)

7. Upon what factor are the classes of veal or calf based? (7-7)

8. The temperature of packaged, chilled veal products must be maintained within what range at the time of shipment and delivery? (7-10)

9. What is the time limit (after preparation) within which frozen veal products must be reduced to 0° F.?

10. Under what conditions can veal cuts be trimmed to meet specified weights? (7-13)

11. List four times when inspection of veal and calf may be conducted. (7-16)

12. What grades of veal carcasses can be used to prepare boneless, frozen veal? (7-18)

13. If the percentage yield for type I, category 2 veal doesn't meet the minimum percent yield, what can the contractor do to make the lot acceptable? (7-19)

14. What is the difference between lamb and ovine? (8-1)

15. Prior to slaughter (while the animal is still alive) how can one differentiate between the ovine age groups of lamb and yearling mutton? (8-2)

16. During an inspection of ovine for military procurement, you look at the distal end of the foreshank. What types of joints could you expect to find? (8-4)

17. Differentiate between the color and texture of the lean of a lamb and a mutton carcass. (8-6)

18. What grades of lamb do the military usually procure? (8-9)

19. Name the three styles of ovine meat. (8-11)

20. What defects should you be especially aware of when inspecting frozen lamb carcasses? (8-13)

21. What military specification governs the requirements for the production and inspection of the wholesale market cuts of lamb? (8-14)

22. How is telescoped lamb prepared that is different from regular lamb carcass processing? (8-16)

23. A lamb carcass must weigh 65 pounds or less if its market cuts are to be used for boneless lamb. What is the maximum weight allowed a hindsaddle derived from this carcass? (8-18)

24. The Government is purchasing frozen boneless lamb from a contractor. Who is normally responsible for all in-processing inspection? (8-21)

25. Why are meat-type hogs more in demand than the lard type? (9-2)

26. The processing of pork is much the same as that of beef with the exception of________________ and ______________________. (9-4)

27. What are the two styles of fresh pork? (9-5)

28. What factors are considered when determining the grade of a pork carcass? (9-8)

29. What is "backfat"? (9-9)

30. Briefly describe the relationship between the percent of lean cuts to fat with regard to the top three grades of pork carcasses. (9-12)

31. Describe the separation points for removing the middle portion from the posterior and anterior portions of a pork carcass. (9-14)

32. What are the two pork cuts that lead in pounds purchased? (9-15)

33. What are the forms and classes of cured bacon? (9-17)

34. Where is the ham separated from the loin in a pork carcass? (9-19)

35. How may an inspector determine the percentage of skin left on a partially skinless ham? (9-21)

36. Unless specified otherwise, fresh pork is delivered in what state of refrigeration? (9-24)

37. Define the temperature limits for chilling fresh pork. (9-25)

38. From what market cut of pork is frozen boneless pork derived? (9-28)

39. After the initial chilling of pork for frozen boneless pork, what is the highest temperature allowable and when? (9-30)

40. Describe the color of the lean a pork loin must possess to be acceptable for frozen boneless pork. (9-32)

41. What carcass portions must be removed from pork loins used for fabricated pork? (9-33)

42. How may an inspector determine whether or not type II, pork loin slices, have been sliced so that they remain intact? (9-35)

43. Describe the purpose and use of a binding agent for boneless pork. (9-37)

44. If a fresh pork product has been inspected at a point other than destination, then the destination inspection should be only concerned with what factors? (9-40)

45. To what extent are bruises allowed if found while inspecting Government-procured pork? (9-41)

46. Although both surface and penetrating molds in pork do not usually impair health, why are they undesirable? (9-43)

47. Why has the necessity for curing pork been reduced? (10-1)

48. In pickle curing, what is the difference between a plain pickle and a compound pickle? (10-4)

49. What instrument can you use to determine the salt content of a pickle solution? (10-5)

50. Describe the "cover" method of pickle curing. (10-8)

51. What weight increase is allowed by the USDA in a ham that is to be cured by the artery pump method? (10-10)

52. While looking over the curing operation in a meat processing establishment, you are told by a representative of the establishment that their operation includes country curing. What is the more correct term for country curing, and what pork product is probably being cured by this method? (10-11)

53. An employee in the "curing cellar" of a meat processing establishment informs you he is going to overhaul meat undergoing modified box cure. What is the employee going to do when he overhauls the meat? (10-12, 13)

54. Why are cured pork cuts never frozen before smoking? (10-16)

55. Heat resulting from smoking pork destroys certain microorganisms and bacteria. Does the smoking of bacon kill trichinae? Explain why or why not. (10-17)

56. What controls the smoked flavor in smoked meat? (10-19)

57. You ask a meat processing establishment representative what type of equipment is used in smoking bacon in his establishment. His answer is "air conditioning." Did he perhaps misunderstand your question? Explain your answer. (10-22)

58. What does the term "drys" relate to and what is its cause? (10-24)

59. You are inspecting cured, smoked bacon and note a gray color in the meat. What is the probable cause of this color? (10-25)

60. In inspecting hams, the loin end, shank, and stifle joint are points we should examine to determine the condition of the product. What three main points should we check on slab bacon? (10-27)

61. What are the three principal classifications of sausages? (11-2)

62. Frankfurters, bologna, and Vienna sausage are all smoked and cooked sausages composed of both beef and pork meat and spices. Is the meat cooked before or after stuffing into casings? (11-5)

63. What varieties of cooked sausages have very short storage lives? (11-6)

64. Dry and summer sausages keep well in warm weather because, due to the lack of moisture, bacterial growth is retarded. Why must the pork in dry sausages be cooked and cured or frozen? (11-8)

65. For what reasons are beef and pork added to sausage? (11-11)

66. What effect does salt have on fat globules and the sausage in general? (11-12)

67. Why is pork ground only once in the production of sausage, whereas beef is ground twice? (11-14)

68. Why is the sausage mixture run through a vacuumizer before stuffing? (11-17)

69. What causes "fat caps" in sausage? (11-19)

70. What is the purpose of chilling sausage after it is cooked? (11-21)

71. What five items are of primary concern when inspecting a sausage processing plant? (11-22)

72. In conducting inspections for fat content in pork sausage, the contract requires a maximum fat content of 40 percent. The contract is for 160,000 pounds, and 1 day's production is about 32,000 pounds. The lot on day 1 tested 41 percent fat. Days 2, 3, and 5 produced lots with 39 percent fat. Day 4's lot contained 42 percent fat. Determine the total percentage of fat and proper disposition for the entire contract. (11-24)

73. What are "touchers"? (11-27)

CHAPTER 4

Objectives: To show an understanding of military procurement distination inspections and surveillance inspections of poultry.

1. What organism that may cause a foodborne illness is found readily in poultry? (Intro. -1)

2. What are the reasons for inspecting poultry that is to be used for food for military personnel? (Intro. -2)

3. When speaking of poultry, what does "type" refer to? (12-2)

4. When inspecting packaged poultry, what differences would you expect to observe between style 4 and style 5 chicken? (12-3)

5. When inspecting dressed and eviscerated poultry to determine the class, what characteristics would you notice in older birds? (12-5)

6. What characteristics are observed in determining the sex of a dressed bird? (12-7)

7. During inspection of a dressed and eviscerated chicken, you observe that the bones are short and rather fine, and the body is definitely rounded from side to side. What would be the probable sex of this bird? (12-8)

8. What maturity relationship exists between male chickens of class II (roasters), class IV (stags), and class VI (cocks)? (12-11)

9. In a poultry processing plant operating under Federal inspection, what portion of the birds must be "US Inspected for Wholesomeness"? What portion must be "US Graded"? (12-13)

10. Explain briefly the meaning of conformation as related to poultry grading. (12-15)

11. Regarding the inspection of fat covering of poultry, what general relationship usually exists with respect to the age of birds? (12-17)

12. What are the vestigial feathers that are sometimes found on poultry? (12-19)

13. What determines the number and extent of tears, cuts, and missing skin allowed on a poultry carcass? (12-20)

14. List two causes of discoloration which is considered a serious poultry grading factor. (12-21,22)

15. What overall grade is given to a chicken if it has been evaluated to have the following individual grade factors? (a) Conformation; pinfeathers; exposed flesh; discolorations; disjointed bones, broken bones, and missing parts; and freezing defects are all A quality. (b) Fleshing and fat covering are B quality. (12-24; Table 12)

16. Normally, what factors should you be concerned with in the destination inspection of poultry? (13-2)

17. When making a destination inspection, how do you determine the temperature of a shipment of poultry? (13-6)

18. When determining the net weight, during a destination inspection, what consideration must be given to the usual packing of poultry? (13-8)

19. When determining the net weight of poultry, one must be sure to weigh what item? (13-10)

20. Although a certain amount of moisture in frozen poultry is highly desirable, what is the effect of an excessive amount? (13-11)

21. What should be done with poultry that had been frozen but was thawed during inspection? (13-12)

22. When you are performing a surveillance inspection, what important controlling factor must be considered that does *not* exist when performing processing and destination inspection? (13-15)

23. How many birds are routinely examined during a surveillance inspection of stored poultry? (13-18)

24. When performing a surveillance inspection, where in a stack of frozen poultry would you select samples to determine if freezer burn exists? (13-19)

25. How do the types of turkeys relate to the types of chickens? (14-2)

26. What can be said of the tolerance allowed in grading factors for turkeys in comparison with that allowed for chickens? Why? (14-4)

27. In addition to wrapping and packing them in the same manner as chicken giblets, how may turkey giblets be placed to give the bird a more plump appearance? (14-5)

28. With respect to the length of time allowed before consumption, how do type II and type III ducks differ? (14-7)

29. How many styles of chickens, turkeys, and ducks are purchased by the US Armed Forces? Why the difference? (14-9)

30. For what primary purpose are ducks procured by the US Armed Forces? (14-11)

ANSWERS FOR CHAPTER REVIEW EXERCISES

CHAPTER 1

1. USDA.

2. Cells are the smallest units of an animal's body.

3. Skin, hair, and hoofs.

4. Connective tissue cells.

5. Skin and appendages.

6. The mucous membranes open to the outside of the body, and the serous membranes line the closed cavities.

The axial skeleton, appendicular skeleton, and joints.

8. Cervical, thoracic, lumbar, ascral, and coccygeal.

9. Thoracic.

10. The sternebrae are separated by cartilage in the young animal and are fused into solid bone in the older animal.

11. Carpus.

12. Aitchbone.

13. Hinge joint.

14. It would display alternate dark and light bonds which run across the muscle fibers.

15. Diaphragm.

16. A central system and a peripheral system.

17. Central system.

18. Chemical reactions result in a breakdown of foods by gastric juices and enzymes to make them usable by the cells of the body.

19. In the head region.

20. (1) Rumen, (2) reticulum, (3) omasum, and (4) abomasum.

21. Pancreatic juices digest protein, carbohydrates, and fats.

22. Pericardium.

23. Lymph carries food to individual body cells and removes their waste.

24. Lymph nodes (glands) may reveal the existence of diseases (such as tuberculosis) which would render the carcass unfit for human consumption.

25. Nasal cavity, pharynx, larynx, trachea, bronchi, and lungs.

26. Kidneys, ureters, bladder, and urethra.

CHAPTER 2

1. *Manual of Meat Inspection Procedures.*

2. MIL-STD 1481, *Sanitary Standards for Meat Processing Plants in Overseas* [illegible]

3. The removal of the internal organs.

4. *a.* Reduces meat shrinkage.
   b. Reduces incidence of external contamination.
   c. Molds the external fat.

5. Since all other conditions were near ideal, but humidity was too high, the carcasses can be expected to be slimy.

6. Heifer.

7. *a.* Aitchbone.
   b. Pizzle eye.
   c. Pizzle eye cap.
   d. Gracilis muscle.
   e. Cod and dug fat.

8. Bean shaped.

9. *a.* Style I, carcass (quartered).
   b. Style II, side.
   c. Style III, forequarter.
   d. Style IV, hindquarter.
   e. Style V, wholesale and fabricated cuts.

10. Two ribs on the hindquarters (both 12th ribs); 24 on the two forequarters (1-12 on each).

11. It is the hindquarter and all of the posterior portion of the side remaining after severance between the 12th and 13th ribs.

12. The rib, primal, and the square-cut chuck.

13. That portion of the forequarter remaining after the shank, brisket, short plate, and rib, primal, have been removed.

14. That portion of the forequarter remaining after the removal of the short plate, foreshank, and square-cut chuck.

15. It is the ventral portion of the sixth through 12th ribs.

16. It is that portion of the hindquarter remaining after the full loin has been removed.

17. Perpendicular to the lumbar vertebrae and just anterior to the pelvis.

18. Refuse to accept it.

19. *a.* Absense of objectionable odors.
    b. Free from ragged edges.
    c. No evidence of freezer burns.
    d. Characteristics of the style, class, grade, and condition specified in the purchasing instrument.

20. The contractor is required to number each quarter in a manner which will assure its identification with a specific carcass.

21. USDA.

22. *a.* Prime.
    b. Choice.
    c. Good.
    d. Standard.
    e. Commercial.
    f. Utility.
    g. Cutter.
    h. Canner.

23. Conformation and quality determine the quality grades.

24. *a.* Proportional weights.
    b. Relative value of the various cuts.

25. By observing the size, shape, and ossification of the bones and cartilages.

26. It is the intramuscular fat and is the source of much of the juiciness of a cooked piece of beef.

27. Cherry red.

28. Choice, good, commercial, utility, cutter, and canner.

29. None. No grade is comparable between classes.

30. Canner.

31. A choice stag would exhibit thick muscling in the round and chucks with moderate thick loins and ribs in conformation. The quality is exhibited by a good exterior fat covering; interior fat in the crotch, breast, and kidneys; a firm flesh with fat found in the seams; and a medium to dark-red color.

32. *a.* One.
    b. A saw cut, perpendicular to the back, is made between the 12th and 13th ribs.

33. Superior conformation can only compensate for deficiencies in quality in grades other than prime, choice, and commercial, and only then to a compensation of one-third.

34. The final grade is based on a composite evaluation of both conformation and quality.

35. *a.* The thickness of external fat (expressed in inches of fat over the ribeye muscle).
    b. The amount of kidney, pelvic, and heart fat (expressed in percent of carcass weight).
    c. The carcass weight (expressed in pounds of hot carcass).
    d. The area of the ribeye muscle (expressed in square inches).

36. Subjectively.

37. One full cutability grade.

38. When unusual conditions exist.

39. Multiply the chilled carcass weight by 102 percent.

40. *a.* The term "2.50" is a constant (used every time).
    b. The term "2.50T" multiplies the constant "2.50" by the variable factor "T" (the thickness of external fat over the ribeye muscle, to the nearest tenth of an inch).
    c. The term "0.20P" is the constant "0.20" multiplied by the variable factor "P" (amount of kidney, pelvic, and heart fat, expressed as percent of carcass weight).
    d. The term "0.0038W" is the constant "0.0038" times the variable factor "W" (weight of hot carcass, or cold weight times 1.02, in pounds).
    e. The term "0.32A" is the constant "0.32" times the variable factor "A" (the cross-sectional area of the ribeye muscle, expressed to the nearest tenth of a square inch).

41. First convert cold weight to hot, or $490 \times 1.02 = 500$ lb approximately
$\text{C. G.} = 2.50 + 2.50T + 0.20P + 0.0038W - 0.32A$
therefore:
$\text{C. G.} = 2.50 + 2.50 \times .5 + .20 \times 3.5 + .0038 \times 500 - 0.32$
$\times\ 10.5 = 2.50 + 1.25 + .70 + 1.90 - 3.36$

$$\begin{array}{r} 2.50 \\ 1.25 \\ .70 \\ +\underline{1.90} \\ 6.35 \\ -\underline{3.36} \\ 2.99 \end{array}$$

therefore:

C. G. = 2

42. 3.0

43. *First*, compute hot carcass weight:

20 × 29.10 (chilled weight × established factor) =
582 lb hot carcass wt.

Second, determine standard percent for kidney, pelvic, and heart fat; that is, "4.5".

Third, write formula:

Cutability group = 2.50 + 2.50T + 0.20P + 0.0038W − 0.32A

Fourth, substitute for variable factors:

C. G. = 2.50 + 2.50 × 0.8 + 0.20 × 4.5 + 0.0038 × 582
− 0.32 × 14.1

Fifth, multiply constants by variables:

C. G. = 2.50 + 2.00 + 0.90 + 2.21 − 4.51

Sixth, collect terms:

$$\begin{array}{r} 2.50 \\ 2.00 \\ 0.90 \\ +\underline{2.21} \\ 7.61 \\ -\underline{4.51} \\ 3.10 \end{array}$$

Seventh, drop fraction:

Therefore: C.G. = 3

44. Prior to shipment of the product; immediately upon the product's arrival at destination; and in storage.

45. The presence of slime, mold, and off odors.

46. It tends to deteriorate rapidly because of the amount of exposed muscle tissue, and from blood and serum drippings from other parts of the carcass.

47. Because blood and serum seepage in the area promotes the growth of spoilage-causing bacteria.

48. Smell a meat trier immediately after it has been inserted into and removed from the ball-and-socket joint; if the sour condition is present, you will detect a noxious odor.

49. On the loin end of the hindquarter or the rib end of the forequarter.

50. Recommend that the carcass be trimmed of all the unwholesome areas and the remainder be used for its intended purpose.

51. Check for overall cleanliness and off odor.

52. The product's condition and temperature.

53. Type is the general category or use of the cut of beef. Style refers to the individual cuts within a certain type.

54. Knuckle, inside round, eye of round, and outside round.

55. Because of their high-quality and palatability.

56. The unsliced boned cut is frozen to 0° F., tempered to 24° F.-28° F., pressed into shape, and then sliced.

57. The same as those used for type I, oven roast.

58. Not less than 5 ½ ounces nor more than 6 ½ ounces.

59. Minute steaks have been mechanically tenderized, whereas swiss steaks have not.

60. No.

61. One-half inch.

62. USDA grade "utility" or better and steer, heifer, and cow carcasses.

63. 22 percent.

64. Primal rib, square-cut chuck, primal round, and full-trimmed loin.

65. The US Government reserves the right to perform any of the inspections indicated in the specification.

66. None. Only labeling and marking of shipping containers is required.

67. In the lower left corner of both ends of the box.

CHAPTER 3

1. Bovine.

2. Lamb.

3. It is meat that has been comminuted and further processed.

4. An immature bovine which is under 3 months of age and has subsisted largely on milk.

5. The hide helps retain a fresh appearance of the meat by controlling loss of moisture until it is presented for sale.

6. The color of the lean.

7. The apparent sex condition of the animal at the time it was slaughtered.

8. 30° F. to 40° F.

9. Four hours.

10. Never; trimming of cuts to meet specified weights is an unacceptable practice.

11. (a) During processing, (b) at completion of processing, (c) in transit, and (d) at destination.

12. Prime, choice, good, and standard.

13. Obtain additional wholesale bone-in cuts of the grade stipulated, meeting temperature and condition requirements.

14. Ovine (sheep) includes all ages of the species, whereas lamb refers to only the young within the species.

15. Lamb is under 14 months of age has not cut its first pair of permanent incisor teeth, whereas yearling mutton will be between 1 and 2 years of age and will have cut its first but not the second pair of incisor teeth.

16. Either break joints, yearling joints, or spool joints.

17. A lamb carcass would exhibit light pink, firm flesh, whereas a mutton carcass would have a very dark red, soft and watery flesh.

18. Prime, choice, and good.

19. Style I–carcass; Style II–fabricated carcass, and Style III–wholesale market and fabricated cuts.

20. Defrosting, refreezing, freezer burn, and contamination.

21. PP-L-92.

22. Telescoped lamb processing is different from regular lamb carcass processing as suggested by its name. The rear half is removed, reversed, and telescoped into the remaining front half. This telescoping is performed after slaughter and prior to freezing.

23. Thirty-three pounds.

24. The contractor.

25. The meat-type hog produces maximum amounts of bacon, ham, and loin which are very popular; whereas, the "lard" type produces fat cuts of meat and large quantities of lard that are no longer desired.

26. Scalding; skinning.

27. Style A–carcasses, and style B–market cuts.

28. The relationship between the average backfat thickness, the carcass length and weight, and the amount of muscling.

29. It is the fatty layer which covers the loin.

30. Among other things, these are requirements for percent of lean cuts to carcass weight:
US number 1–more than 50 percent, US number 2–47 to 50 percent, and US number 3–less than 47 percent.

31. The posterior portion is removed by cutting perpendicularly to an imaginary line drawn through the center of the shank to the tip of the aitchbone. This cut should be 2 ¼ to 2 ¾ inches below the aitchbone, or about the width of three fingers. The anterior portion is removed by making a cut along a line perpendicular to the chinebones, leaving no less than one nor more than 2 ½ on the anterior portion.

32. Bellies and hams.

33. Cured bacon forms are form A–slab and form B–sliced. The classes are class 1–chilled and class 2–frozen.

34. It is separated 2 ¼ to 2 ¾ inches anterior to the exposed knob end of the aitchbone.

35. By determining the skin's proportion of the lengthwise measurement from the approximate center at the edge of the ham butt to the extreme outer tip of the shank end.

36. Chilled.

37. Fresh chilled pork must be thoroughly chilled to an internal temperature range of 28° F. to 40° F. at the center of the thickest pieces promptly after slaughter and maintained within these temperatures until delivery.

38. Pork loin.

39. After boning and until frozen, boneless pork cannot exceed 42° F.

40. To be acceptable as frozen boneless pork, the lean of pork loins must possess a bright uniform color, ranging from light pink or greyish pink to bright red, and the flesh must not be dark.

41. Flank meat, tenderloin, blade meat, bone, cartilage, blood clots, bruises, semiattached fat or tag ends, and surface fat in excess of one-fourth inch in thickness.

42. Lift the entire slice with a fork inserted at the approximate center of one of the halves after it has been cooked. The two halves must remain intact as one piece.

43. A binding agent is used to hold the interior surface lean together. It is best applied prior to processing the loin into boneless roasts and slices.

44. Condition and identity.

45. Surface bruises involving the skin are allowable, but those affecting the lean or fat tissue are not acceptable.

46. Molds in pork are undesirable because they impart undesirable flavors.

47. The necessity for curing pork has been reduced because pork can now be satisfactorily preserved by chilling and freezing.

48. A plain pickle is a simple solution of salt and water. A compound pickle contains salt, water, and one or more curing agents.

49. A salometer.

50. The meat is placed in vats where it is completely submerged in pickle.

51. Ten to 12 percent if the product is returned to the uncured weight after it is smoked.

52. The more correct term for country curing is dry-salt curing. The pork product probably being cured by this method is salt pork from large sow bellies.

53. Modified box cure is a variation of dry box cure. The principle difference is that the natural liquor is tested as the basis for providing uniform solutions, which are prepared and placed in each box. The employee in overhauling the meat will change the position of the individual cuts of meat in the boxes. For example, the cuts on top may be moved to the bottom, those in the middle to the top, and those on the bottom to the middle of the boxes.

54. Because frozen cuts lose meat juices and dehydrate too much.

55. No, because trichinae is only killed at 137° F. or higher. Bacon is only cooked and smoked to 120° F.

56. The kind of wood used in the smoking process.

57. He is technically correct in his answer to your question. Smoke forced with circulation equipment is referred to as "air conditioned."

58. "Drys" relates to common defects found in smoked meats. This condition results from excessive heat during the smoking process, which causes excessive shrinkage.

59. Lack of nitrite during the curing process.

60. Flank pocket, featherbone line, and brisket end.

61. Domestic, dry, and summer.

62. After.

63. Those that contain blood and liver.

64. To kill trichinae.

65. Beef is added for binding, and pork is added for flavor, juiciness, and tenderness.

66. A salt and ice water combination solubilizes proteins to help protect fat globules from rupturing during smoking and cooking. Salt also acts as a curing agent and a preservative to inhibit bacterial growth, and it accentuates natural flavors.

67. Pork is more tender than beef and contains a larger amount of fat.

68. To extract any excessive air that resulted from the chopping in the silent chopper.

69. If the heat in the smokehouse is applied to quickly, for too long, or is too high, the collagen converts to gelatin and drains away from the fat particles. This causes the fat to separate from the meat and settle into fat caps.

70. To stop the cooking and to stop the growth of bacteria as quickly as possible in order to obtain maximum storage life.

71. Equipment, laboratory testing, raw material, workmanship, and the finished product.

72. Total percentage is 40 percent fat, which is within required limits, making all lots produced acceptable.

73. Two sausages that have touched each other, leaving an area where smoke has not penetrated.

CHAPTER 4

1. Salmonella.

2. To assure that all poultry products are derived from healthy birds (wholesomeness) and to determine contractual compliance.

3. The state of refrigeration.

4. With style 5 chicken, the legs would include the drumstick and thigh intact, and the pieces would not necessarily be packaged in the proportion in which they appear on the carcass, as with style 4.

5. The cartilage on the tip of the breastbone would be firm and rigid; the carcass would be blocky; the meat would be darker in color and tougher in texture; and the fat deposits would be patchy.

6. The body, skin, keel, and legs.

7. Female.

8. Maturity of class IV (stags) is intermediate between class II (roasters) and class VI (cocks).

9. All birds must be "US Inspected for Wholesomeness," whereas all, some, or none of the products are "US Graded."

10. Confirmation refers to the general outline or shape of the bird and is based primarily on the skeletal structure.

11. Younger birds do not display fat covering to the degree that older birds do.

12. Imperfectly developed feathers of two types: hair and down.

13. Their location.

14. Skin pigment characteristics and bruises.

15. B quality.

16. Condition, identity, count, net weight, and temperature.

17. Several thermometers are used; some are placed throughout the load, and others are placed in the poultry products. An average of the readings of all of the thermometers is considered to be the temperature of the shipment.

18. Each individual wirewound wooden box must be weighed to establish the tare.

19. The giblets.

20. The cost of the product is increased because the excess water (ice) adds to the net weight of the products.

21. They should be kept in the chilled state. They should not be refrozen.

22. The products under surveillance inspection are Government-owned. Maintaining them in good condition, rather than rejecting those which are unwanted, is the major objective of surveillance inspections.

23. Five percent.

24. Boxes on the top or sides of the stack.

25. They are the same.

26. More tolerance is allowed in grading factors for turkeys because of their larger size.

27. The wrapped giblets, with the unwrapped neck, may be placed under the skin in front of the breast in the region of the crop.

28. Type II birds may be frozen for less than, and type III birds for more than, 60 days.

29. Five styles of chickens, four styles of turkeys, and three styles of ducks. Difference in the number of styles is caused by the relatively fewer turkeys and ducks purchased.

30. To supply the commissary for resale.

STOP – **1. MATCH ANSWER SHEET TO THIS EXERCISE NUMBER.** **2. USE NUMBER 1 PENCIL.**

90850 03 22

VOLUME REVIEW EXERCISE

Carefully read the following:

DO'S:

1. Check the "course," "volume," and "form" numbers from the answer sheet address tab against the "VRE answer sheet identification number" in the righthand column of the shipping list. If numbers do not match, take action to return the answer sheet and the shipping list to ECI immediately with a note of explanation.
2. Note that numerical sequence on answer sheet alternates across from column to column.
3. Use only medium sharp #1 black lead pencil for marking answer sheet.
4. Circle the correct answer in this test booklet. After you are sure of your answers, transfer them to the answer sheet. If you *have* to change an answer on the answer sheet, be sure that the erasure is complete. Use a clean eraser. But try to avoid any erasure on the answer sheet if at all possible.
5. Take action to return entire answer sheet to ECI.
6. Keep Volume Review Exercise booklet for review and reference.
7. If *mandatorily* enrolled student, process questions or comments through your unit trainer or OJT supervisor.
   If *voluntarily* enrolled student, send questions or comments to ECI on ECI Form 17.

DON'TS:

1. Don't use answer sheets other than one furnished specifically for each review exercise.
2. Don't mark on the answer sheet except to fill in marking blocks. Double marks or excessive markings which overflow marking blocks will register as errors.
3. Don't fold, spindle, staple, tape, or mutilate the answer sheet.
4. Don't use ink or any marking other than with a #1 black lead pencil.

NOTE: TEXT PAGE REFERENCES ARE USED ON THE VOLUME REVIEW EXERCISE. In parenthesis after each item number on the VRE is the *Text Page Number* where the answer to that item can be located. When answering the items on the VRE, refer to the *Text Pages* indicated by these *Numbers*. The VRE results will be sent to you on a postcard which will list the *actual VRE items you missed*. Go to the VRE booklet and locate the *Text Page Numbers* for the items missed. Go to the text and carefully review the areas covered by these references. Review the entire VRE again before you take the closed-book Course Examination.

Multiple Choice

1. (001) What are the smallest units of an animal's body?

   a. Cells.
   b. Veins.
   c. Arteries.
   d. Tissues.

2. (001) Which of the following structures is composed of epithelial tissue?

   a. Skin.
   b. Muscle.
   c. Kidneys.
   d. Arteries.

3. (002) Epithelial tissues which open to the outside of the body are called

   a. sympathetic membranes.
   b. connective tissues.
   c. serous membranes.
   d. mucous membranes.

4. (002) What are the three major components of the complete skeletal system?

   a. Axial skeleton, cranial bones, and joints.
   b. Cranial bones, vertebral column, and pelvic limb.
   c. Appendicular skeleton, irregular bones, and joints.
   d. Joints, axial skeleton, and appendicular skeleton.

5. (002) The sternum of young animals is

   a. solid bone.
   b. white fatty tissue.
   c. yellow elastic tissue.
   d. separated by cartilage.

6. (004) If you examine a muscle microscopically and find that it is striated, how should you classify it?

   a. Back muscle.
   b. Flexor muscle.
   c. Voluntary muscle.
   d. Involuntary muscle.

7. (006) Into what two systems is the nervous system divided?

   a. Peripheral and thoracic.
   b. Central and peripheral.
   c. Central and cranial.
   d. Thoracic and sacral.

8. (007) Where are the three major salivary glands located in the bovine?

   a. Near the liver.
   b. In the stomach.
   c. In the esophagus.
   d. In the head region.

9. (007) How many compartments does the stomach of the bovine contain?

   a. 2.
   b. 3.
   c. 4.
   d. 5.

10. (008) The fibrous tissue that surrounds the heart is called the

a. myocardium.
b. epicardium.
c. endocardium.
d. pericardium.

11. (008) Why is it important that you thoroughly examine the lymph glands of animals being processed for human food?

a. They may reveal the presence of disease.
b. They must be graded for food quality.
c. They are important organs of the blood vascular system.
d. They filter the white blood cells in the lymph vessels.

12. (008) Which of the following groups consist only of parts of the urinary tract?

a. Bladder, kidneys, testes, and ovaries.
b. Kidneys, ureters, bladder, and urethra.
c. Urethra, ureters, kidneys, and fallopian tubes.
d. Fallopian tubes, prostate, kidneys, and urethra.

13. (009) The term "evisceration" refers to the

a. skinning of the animal.
b. removal of the intestines.
c. removal of all internal organs.
d. removal of the heart and lungs.

14. (009-010) Covering the surface of a side of beef with heavy muslin which has been wrung out in plain hot potable water or hot salt brine is called

a. chilling.
b. shrouding.
c. ribbing.
d. wrapping.

15. (010-011) How would you classify beef produced from a female bovine which has *not* attained full sexual maturity?

a. Cow.
b. Calf.
c. Veal.
d. Heifer.

16. (012) A female carcass may be identified by the

a. bean-shaped gracilis muscle.
b. pizzle eye cap.
c. pizzle eye.
d. cod fat.

17. (012) When separating the forequarter and hindquarter of a beef carcass, the cut is made

a. between the 11th and 12th ribs.
b. between the 13th and 14th ribs.
c. between the 12th and 13th ribs.
d. between the 12th and 13th lumbar vertebrae.

18. (013) If the rib, primal, and the square cut chuck are kept in one piece, the cut is referred to as the

    a. back.
    b. full chuck.
    c. full rib.
    d. cross-cut chuck.

19. (013) The ventral portion of the sixth through twelfth ribs is usually referred to as the

    a. brisket.
    b. foreshank.
    c. spareribs.
    d. shortplate.

20. (014) That portion of the hindquarter remaining after the full loin has been removed is called the

    a. heel of round.
    b. round, primal.
    c. loin end.
    d. sirloin.

21. (016) Which of the following two factors collectively establish the quality grade of meat?

    a. Conformation and quality factors.
    b. Cutability and quality factors.
    c. Conformation and cutability.
    d. Cutability and cost.

22. (016) In evaluating various cuts of a beef carcass to establish overall conformation, what are the two prime consideration factors?

    a. Quality and proportional weights.
    b. Cutability and proportional weights.
    c. Cutability and relative value of the various cuts.
    d. Proportional weights and relative value of the various cuts.

23. (017) What color is the most desirable for a cut of fresh beef?

    a. Dark red.
    b. Cherry red.
    c. Light pink.
    d. Cherry pink.

24. (020) Which of the following characteristics would you expect to find when inspecting a high grade stag carcass?

    a. Thin rounds.
    b. Light red colored lean.
    c. Thick and heavily fleshed chucks.
    d. Small amounts of exterior fat covering.

25. (020) When ribbing a side of beef, where is the saw cut made?

    a. Down the back.
    b. Between the 5th and 6th ribs.
    c. Across the 12th and 13th ribs.
    d. Between the 12th and 13th ribs.

26. (022) To adjust the chilled carcass weight to hot carcass weight, what numerical calculations must be made?

    a. Multiply the chilled carcass weight by 102 percent.
    b. Multiply the hot carcass weight by 102 percent.
    c. Subtract the two weights and multiply the difference by 102.
    d. Add 10 percent of the hot carcass weight to the chilled carcass weight.

27. (02[illegible]) What determines the standard percentage figure used for kidney, pelvic, and heart fat in calculating the cutability grade for a trimmed forequarter?

    a. The sex of the animal.
    b. The grade of the carcass.
    c. The weight of the carcass.
    d. The amount of external fat on the carcass.

28. (025) Which one of the human senses is most often used in determining whether or not a beef carcass has a sour round?

    a. Smell.
    b. Taste.
    c. Sight.
    d. Touch.

29. (025) If you were to find evidence of off-condition or a latent defect on carcass beef after Government acceptance, what would your course of action be?

    a. Recommend that the beef be issued immediately.
    b. Recommend that the product be rejected.
    c. Recommend that purchases from that vendor be discontinued.
    d. Recommend that the beef be trimmed of all the unwholesome areas and then issued.

30. (027) In the production of Type IIIA, grill steaks (formed), the slicing process occurs

    a. after the cut has been tempered and molded.
    b. before the initial freezing of the cut.
    c. after the cut has been frozen but before it has been tempered.
    d. after the cut has been tempered but before it is molded into shape.

31. (027) Which one of the following cuts is used in the production of swiss steak?

    a. Clod.
    b. Knuckle.
    c. Sirloin butt.
    d. Chuck roll (neck end)

32. (028) The main difference between minute steaks and swiss steaks is that

    a. swiss steaks are smaller than minute steaks.
    b. different cuts of meat are used in the production of each.
    c. minute steaks have been mechanically tenderized, whereas swiss steaks have not.
    d. swiss steaks have been mechanically tenderized, whereas minute steaks have not.

33. (029) Which one of the following cuts of meat may *not* be used in the production of diced beef?

a. Shank meat.
b. Primal rib.
c. Primal round.
d. Square-cut chuck.

34. (029) What labeling and marking of individually wrapped or packaged fab beef cuts is required?

a. The pertinent specification number is affixed to the wrapper.
b. Applicable contract number must be affixed to the wrapper.
c. None. Labeling is placed on the container.
d. The grade of the cut must be identified.

35. (031) Meat that has been comminuted and then processed is called

a. sausage.
b. diced meat.
c. ground meat.
d. fabricated meat.

36. (031) In "cold skinning" of veal and calf carcasses, the skin or hide is not removed until after the carcass is chilled because the

a. meat is easily contaminated and would spoil.
b. hide allows for inspection and required trimming.
c. buyer judges the carcass on the condition of the hide.
d. hide helps retain the bloom by controlling loss of moisture.

37. (034) A young ovine under 14 months of age is referred to as a

a. lamb.
b. mutton.
c. yearling lamb.
d. yearling mutton.

38. (034) A yearling mutton is an ovine that

a. is between 3 and 8 months old and has subsisted partially or entirely on foods other than milk.
b. is over 2 years of age and has cut its second pair of permanent incisor teeth.
c. has cut its first pair of incisor teeth and is between 12 and 24 months old.
d. has not cut its first pair of permanent incisor teeth.

39. (036) The meat from an ovine carcass with spooljoints on the front shanks, wide ribs (not evenly traced with red), patchy fat, and dark red, coarse-textured lean meat is

a. lamb.
b. mutton.
c. positively yearling mutton.
d. either lamb or yearling mutton.

40. (039) Who is normally responsible for all in-processing inspection of frozen boneless lamb purchased by the Government?

a. The USAF Veterinary Service.
b. The contractor.
c. The USDA.
d. DPSC.

41. (039) What step used in processing pork carcasses is *not* used in the processing of beef carcasses?

- a. The carcass is chilled immediately after processing.
- b. The animal is stunned before slaughter.
- c. The carcass is scalded and scraped.
- d. The carcass is washed.

42. (039-040) The layer of fat which covers the loin of a pork carcass is called

- a. jowl.
- b. backfat.
- c. caul fat.
- d. clear plate.

43. (041) The two pork cuts that lead in total pounds procured are the

- a. belly and shoulder.
- b. ham and shoulder.
- c. belly and ham.
- d. loin and belly.

44. (043) Bacon is procured in two forms and two classes. The class designates the state of refrigeration. The form designates

- a. if it is sliced or uncut.
- b. the type of curing.
- c. the style of packaging.
- d. whether is has skin on or is skinless.

45. (044) What is the maximum percentage of the entire back (skinside) surface that the skin collar is allowed to cover on a partially skinned, shank-on ham?

- a. 35 percent.
- b. 40 percent.
- c. 45 percent.
- d. 50 percent.

46. (044) Fresh pork must be chilled immediately after slaughter to an internal temperature of

- a. no higher than 0° F.
- b. 40° F. or lower.
- c. 38° F. or lower.
- d. 32° F. or lower.

47. (045) Boned fresh pork cannot exceed a temperature of 42° F.

- a. until delivery.
- b. until the product is packaged.
- c. anytime until placed in the freezer.
- d. except under the direction of the inspector.

48. (045) In the production of pork loins, what is the external fat thickness allowed on any cut?

- a. 1/8 inch.
- b. 1/2 inch.
- c. 1/4 inch.
- d. 3/4 inch.

49. (046) Vital wheat gluten is necessary when processing pork loins into boneless roasts and slices to

- a. add needed vitamins lost during processing.
- b. hold the interior surface of the lean together.
- c. preserve the color of the meat.
- d. improve flavor as a spice.

50. (046) Select an acceptable condition if found when inspecting pork.

a. Hair roots.
b. Untrimmed seeds.
c. Surface skin bruises.
d. Foreign or sexual odors.

51. (047) A pickling solution which contains salt, water, sugar, and sodium nitrate is commonly referred to as a

a. plain pickle.
b. soapy pickle.
c. cover pickle.
d. compound pickle.

52. (047) In the curing of pork, a salometer is used to determine the

a. salt content of the solution.
b. degree of cure the meat has obtained.
c. length of time the meat must be cured.
d. specific gravity of the curing solution.

53. (048) What commercially cured pork products exclusively use the dry-salt cure method?

a. Hams.
b. Loins.
c. Salt pork.
d. Shoulders.

54. (048) An employee in a meat processing establishment asks you if you would like to watch him overhaul some pork in the curing cellar. His procedure is to

a. sort and wash salt pork in preparation for box curing.
b. sort the various cuts into separate categories in preparation for curing.
c. rearrange pork undergoing box cure to insure an adequate and uniform cure.
d. check the pickling solution for proper strength, and replace it if necessary.

55. (049) A temperature above 137° F. during the smoking process is

a. damaging to hams.
b. a cause of excessive shrinkage.
c. sufficient to render trichinea harmless.
d. used for smoking hams that were frozen after curing.

56. (050) The principal classifications of sausages are domestic, dry, and summer, based on the

a. origin of the product.
b. way the product is processed.
c. moisture content of the product.
d. types of meat and spices added to the product.

57. (050) Which one of the following sausages would have the shortest storage life?

a. Salami.
b. Bologna.
c. Liverwurst.
d. Frankfurters.

58. (051) What qualities does pork add to sausage?

a. Stabilizes the fat globules.
b. Flavor, juiciness, and tenderness.
c. Allows for a more complete grinding.
d. Reduces the overall cost of the product.

59. (051) To prevent the entrapment of air pockets within the sausage product, the sausage mixture is run through a

a. pneumatic casing machine.
b. silent cutter.
c. vacuumizer.
d. stuffer.

60. (051-052) Sausage processing includes grinding, processing in a silent cutter, vacuumizing, stuffing, and smoking and cooking. What can cause "fat caps" during the smoking and cooking process?

a. Insufficient vacuumizing of the product.
b. Too much fat added during the grinding process.
c. Improper stuffing of the product into the casing.
d. Heat is applied too quickly, excessively, or too long.

61. (054) Salmonella is especially prevalent in

a. beef.
b. pork.
c. lamb.
d. poultry.

62. (055-056) When inspecting dressed and eviscerated poultry to determine the class, which of the following groups of characteristics would be expected with an older bird?

a. Hard, rigid breastbone; light colored meat; and patchy fat.
b. Soft, flexible breastbone; dark colored meat; and blocky body.
c. Soft textured meat that is light colored; and rangy body.
d. Dark colored meat; rigid breastbone, and blocky body.

63. (056) During the inspection of a dressed chicken, you note that the bones are short and rather fine and the body is rounded from side to side. The bird is probably a

a. male.
b. stag.
c. female.
d. roaster.

64. (056) Conformation of poultry refers to the

a. general shape of the bird.
b. distribution of flesh on the bird.
c. fat covering displayed on the bird.
d. degree of finish displayed on the bird.

65. (059) To determine the temperature of a shipment of poultry at destination, you should

a. insert a thermometer in the middle bird in the middle box and use it as the delivery temperature.
b. place several thermometers throughout the delivery vehicle and poultry product and use the average reading of all of them as the delivery temperature.
c. place several thermometers in the middle of the delivery vehicle and take the average reading as the delivery temperature.
d. place a thermometer near the front of the delivery vehicle and use this one reading as the delivery temperature.

66. (059) When determining the net weight, during a destination inspection, what consideration must be given the usual packing of poultry?

a. The net weight should be recorded on the box with crayon or pencil.
b. The gross weight should be recorded on the box with crayon or pencil.
c. Each individual wirebound wooden box must be weighed to establish the gross.
d. Each individual wirebound wooden box must be weighed to establish the tare.

67. (059) What is the result of packing and freezing poultry in large quantities of water?

a. Increased cost.
b. Decreased fleshing.
c. Decreased conformation.
d. Increased discoloration.

68. (061) In addition to wrapping and packing them in the same manner as chicken giblets, how may turkey giblets be placed to make the bird more appealing to the buyer?

a. In the region of the crop.
b. Separately from the bird.
c. Separately with the bird.
d. In the body cavity.

69. (061) How many styles of chickens, turkeys, and ducks are purchased by the US Armed Forces?

a. Three styles of chicken, four of turkeys, and five of ducks.
b. Four styles of chickens, three of turkeys, and five of ducks.
c. Four styles of chickens, five of turkeys, and three of ducks.
d. Five styles of chickens, four of turkeys, and three of ducks.

70. (061) Most of the dressed ducks procured by the US Armed Forces are for

a. commissary resale.
b. officer clubs.
c. troop issue.
d. BX use.

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VETERINARY SPECIALIST

(AFSC 90850)

Volume 4

Animal Service; Military Working Dogs; Fresh Fruits and Vegetables;/Waterfoods;/Dairy Products

Extension Course Institute

Air University

Preface

THE BROAD SCOPE of the material in this volume shows the diversification of knowledge and skill required of people in the Veterinary Career Field. Few specialists get the opportunity to be assigned in so many different, interesting areas. On the other hand, you realize that corresponding responsibilities accompany these opportunities. Your ability to assume the responsibilities and to perform efficiently can be greatly expanded by the information presented here.

In the first chapter of this volume you will study animal service pertaining to privately owned animals. You will learn procedures related to quarantine and clinic operation. Diseases related to small animals are also discussed. The second chapter explains the criteria for selecting military working dogs and the principles for maintaining their good health. The succeeding chapters are devoted to ways to assure that the fruits, vegetables, waterfoods, and dairy products of Air Force personnel are wholesome and that they are safely preserved and packaged.

If you have questions on the accuracy or currency of the subject matter of this text, or recommendations for its improvement, send them to the School of Health Care Sciences/MST, Sheppard AFB TX 76311.

If you have questions on course enrollment or administration, or on any of ECI's instructional aids (Your Key to Career Development, Study Reference Guides, Chapter Review Exercises, Volume Review Exercise, and Course Examination), consult your education officer, training officer, or NCO, as appropriate. If he can't answer your questions, send them to ECI, Gunter AFS, Alabama 36118, preferably on ECI Form 17, Student Request for Assistance.

This volume is valued at 24 hours (8 points).

Material in this volume is technically accurate, adequate, and current as of August 1974.

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MODIFICATIONS

Chapter 1, section 1 of this publication has (have) been deleted in adapting this material for inclusion in the "Trial Implementation of a Model System to Provide Military Curriculum Materials for Use in Vocational and Technical Education." Deleted material involves extensive use of military forms, procedures, systems, etc. and was not considered appropriate for use in vocational and technical education.

2. Animal Diseases

2-1. An animal's condition has much to do with its ability to resist infection and disease. In addition, we immunize animals for contagious diseases and treat animals with diseased conditions that are not communicable. In order to identify, treat, and control diseases, we must understand the factors that influence their occurrence: the agents that cause disease, their portals of entry into the host, and how they are spread. In controlling diseases, we must know the clinical symptoms as well as the modes of transmission. This section directs its attention to diseases within the following groups: (1) zoonotic, (2) communicable, but not zoonotic, (3) noncommunicable, and (4) parasitic. First though, let's discuss the epidemiology of diseases.

2-2. **Epidemiology.** The term "epidemiology" is derived from the word "epidemic," which originates from a Greek word "epidemos," meaning "among the people." Epidemiology is the study of all the factors that influence the occurrence of diseases in a community. Today, the term "epidemiology" may also be used to define the study of all the factors that contribute to the cause of disease, and to the establishment and spread of both human and animal disease. Now we will discuss in general, how diseases occur, how they spread, and how to control them.

2-3. *Disease occurrence.* The causes of disease may be classified into primary and secondary factors. Primary factors are the specific agents that cause disease, while secondary factors are conditions or characteristics that influence the development of disease.

2-4. First we will discuss the primary factors which can be either nonliving (physical and chemical) or living (bacteria, viruses, fungi, and parasites). The physical nonliving agents include injuries, such as scalding, freezing, and ionizing radiation. The chemical agents include poisons, photosensitizing agents, and nutritional imbalance. Some living agents can reproduce and multiply within a host. Others, such as the larvae of the hookworm, must develop in the soil before a man or a dog can become infected. One important characteristic of the living organisms which influence disease, is their virulence or disease-producing power.

2-5. The number of organisms that attack a host may determine whether the host will develop the disease. If an insufficient number of infectious agents attack, the host may be able to combat the invading organisms through immunity, its own resistance. Common portals of entry for an organism into the host are the eyes, skin, respiratory tract, digestive tract, and reproductive tract. Parasites, such as mites or the larvae of hookworms, create their own portals of entry through the skin.

2-6. Two different species of organisms working together often produce disease. A bacterial disease may not be serious by itself, but in conjunction with a virus it may be severe. An example is *brucella bronchiseptica* infection concurrent with distemper in dogs. When merely the bacteria are involved, only a mild tracheitis or bronchopneumonia occurs, but when the organism is found in conjunction with canine distemper, a fatal disease may result.

2-7. Sometimes a disease may develop as a result of one pathogen after another pathogen has been destroyed. For instance, fungi frequently invade tissues after bacteria are removed by antibiotics. Also, antibiotic-resistant strains of organisms may develop after antibiotics have been used. For example, ticks can develop resistance to dips used in treatment or prevention, and mutations can occur among some of the virus diseases. Cases of mutations are known in foot-and-mouth disease and in infectious hepatitis.

2-8. Now that we have discussed the primary factors, let's find out about the secondary factors. Some of the secondary factors in the development of disease which we will discuss are sex, age, nutritional status, housing, climate, and trauma.

2-9. Some diseases develop more frequently in one sex than in the other. Leptospirosis is a disease usually transmitted through urine and is much more prevalent in the male dog than in the female. Sex is a factor because the male dog urinates in many areas and smells and licks the areas of urination of other dogs.

2-10. Young animals are generally more susceptible to infection than are older animals. Older animals have usually had more exposure to infectious agents and have developed some immunity.

2-11. Animals in a good state of nutritional health are more resistant to disease than are animals which are suffering from malnutrition. Endoparasites, parasites that live inside the bodies of their hosts, usually affect underfed animals more frequently and more severely than they affect well-nourished animals.

2-12. Animals subjected to cold, damp, poorly ventilated, dirty housing become very susceptible to disease. Climate is a factor in the growth and development of disease organisms, vectors, and intermediate hosts. The anthrax organism will develop spores at temperatures below 70°F. In dry weather, the snails which are intermediate hosts for liver flukes become dormant, and the parasites cease to develop until rains resume. Disease organisms that are dependent on insect vectors are limited to the same geographic area as are the vectors.

2-13. *Spread of disease.* The transmission of disease involves the transfer of the causative agent to a new host and the establishment of the disease in this host. We will discuss some factors which can influence the transfer of a living disease organism, as well as some means by which transfer can occur.

2-14. Diseases can be transmitted by direct contact with an infected animal or by a variety of vectors; the vehicles by which an infectious agent (germ) is transferred from an infected animal or person to a susceptible host. Vectors include arthropods and intermediate hosts. Water, wind, and fomites can also serve as a means by which diseases can be spread.

2-15. When the susceptible population is large, there is a great possibility for transfer of organisms from one animal to another. Disease organisms that multiply rapidly and have a short incubation period can spread through susceptible populations very quickly. In a large susceptible population an epidemic may be established in a very short period.

2-16. Preventing or controlling the spread of diseases is easier than treating diseases that have become widespread. Controlling a disease involves identifying it, carrying out measures to prevent it or to reduce its spread, and, finally, treating individuals affected by it. Disease control agencies, individuals, groups of individuals, and State and Federal Government personnel can participate in disease control activities. Diseases, such as foot-and-mouth disease, rabies, and tuberculosis, are usually controlled under direction of Federal and State agencies, principally because of the impact they could have on the economy and on the health of the human population.

2-17. The three basic procedures for controlling disease are: (1) to prevent or reduce contact between infected and noninfected animals and between infected animals and man, (2) to increase the resistance of the host, and (3) to treat the infected host.

2-18. The first control procedure, preventing or reducing contact between infected and noninfected animals and between infected animals and man, is usually accomplished by restricting the importation of sources of infection. We restrict the use of infected animal products and the movement, slaughter, and disposition of infected and contact animals. We also control carriers, vectors, and intermediate hosts, and we disinfect infected materials.

2-19. The second control procedure, increasing the resistance of the host, is done by treating susceptible animals with prophylactic drugs or vaccines. The last of the three basic procedures, treating infected animals, reduces the possibility of transferring the infection. An example of this third procedure is treating all dogs that demonstrate live microfilaria of heartworm. Treatment should greatly reduce the incidence of heartworm infection in new definitive hosts, because it will tend to eliminate the reservoir of the infectious agent.

2-20. There are many ways by which man can contract zoonotic diseases. Infection can occur by contacting the tissues of diseased animals during slaughtering operations and by eating improperly cooked tissues from infected animals. Contaminated water and arthropod vectors can also spread diseases of animals to man. Although there are many serious zoonotic diseases, we will confine our discussion to three: rabies, leptospirosis, and ringworm. Each of these diseases can affect large numbers of people, and will if proper control procedures are not used continuously. The best known, and most dreaded, of these diseases, of course, is rabies.

2-21. *Rabies.* The virus that causes rabies exists in the saliva of affected animals. This infectious saliva is introduced into the human body through the infected animal's bite or scratch wounds. The virus may be present in the saliva of infected animals for a few days before the onset of symptoms. Therefore, animals may transmit the disease before they exhibit signs of being infected. The dog is the animal that has been chiefly responsible for spreading rabies to man because of its close association with humans. However, rabies is not uncommon in felines, and a rabid cat is certainly capable of inflicting severe lacerations with its claws and teeth. Wild animals, such as skunks, wolves, foxes, and coyotes, can also transmit the disease to people. These uncontrolled wild animals lose their natural fear of man when infected with rabies, and they will often venture into thickly populated areas. Infected bats can also transmit rabies. These animals exist in large numbers in colonies and have been captured while attacking humans or animals.

2-22. Rabies is an acute, fatal disease which may affect any warm-blooded animal. Once the virus has been deposited on or near a nerve of a susceptible animal, it moves up the nervous system until it reaches the brain, where it attacks and destroys the nerve cells. The virus then travels to the salivary glands, where the transmission of the disease to other animals or man is made possible. The incubation period may vary from 15 days to 1 year, but it is usually less than 3 months.

2-23. The first symptom of rabies in any animal may be a slight change in its behavior. Most animals in the prodromal (beginning) stage of the disease are nervous and excitable. Dogs in this stage may seem overly friendly, and they are attracted to groups of people. Although prodromal dogs do not attack, they resent being handled and will bite those who attempt to pet or handle them. The first signs of changes in behavior are difficult to distinguish from digestive disorders, injuries, foreign objects in the mouth, poisonings, or early stages of many other infectious diseases. The prodromal phase may last 1 or 2 days; then, the disease takes either the furious or the dumb (paralytic) form.

2-24. Most people think of rabies only as in the furious form. This second phase of the disease represents the so-called "mad dog" condition. An animal that has the furious form of rabies becomes a vicious, biting terror, completely without fear. It will bite and attack anything that moves in its path. An animal victim of this phase of the disease will show extreme alertness and excitement, and will exhibit widely dilated pupils. Salivation may or may not be evident. In this stage, dogs frequently travel great distances. The furious phase rarely lasts longer than a day or two and, in some instances, may occur for a very short period or maybe not at all.

2-25. In the dumb form of rabies, the animal shows no excitement whatsoever and is sluggish and morose. Saliva usually drools from its mouth because its throat muscles are paralyzed. In many cases the animal's lower jaw hangs open. Because of the open jaw and the salivation, the owner may suspect that a bone or other foreign object is lodged in the animal's throat. Searching for these objects with bare hands is a frequent reaction with concerned owners. Although the animals are not vicious and usually are not able to bite, this search is a dangerous practice because the saliva is a certain source of infection. An animal with dumb rabies will usually live for only a day or two before becoming completely paralyzed.

2-26. Although the usual symptoms may be sufficient to cause suspicion, the animal should be referred to a veterinarian for positive diagnosis. This diagnosis involves sending the head of the suspected animal to a laboratory. At the laboratory, tissue from the brain is examined microscopically, usually by two techniques. The first and oldest technique is examination for Negri bodies which appear in a specific location in the brain in terminal stages of the disease and which stain with certain dyes. The other technique is to demonstrate fluorescent antibodies which, when present, will appear with a characteristic glow. If both of the techniques yield negative results, rabies usually is not present, but these tests do not entirely exclude the possibility of rabies infection.

2-27. As an added precaution, mice are usually inoculated with a suspension of brain tissue from the suspect animal and are observed for 30 days. If rabies virus is present, the mice will die with rabies within this period, and Negri bodies and fluorescent areas can be found on stains of their brain tissue. If at all possible, rabies suspects should be captured and confined and the disease allowed to progress until the animal dies. Killing animals too soon may reduce the accuracy of laboratory diagnosis, because Negri body development is directly related to the length of the animal's clinical illness with rabies.

2-28. When a dog has bitten someone or is suspected of having rabies, it should be quarantined for 10 days. Because of the rapid progress that rabies makes, signs will probably be observable in the animal within a day or two. If symptoms of rabies start to show during the quarantine period, there is usually sufficient time to start prophylactic treatment of the person who was bitten.

2-29. We prevent rabies by immunizing

susceptible hosts, primarily dogs and cats. Air Force Regulation 163-4, *Prevention and Control of Communicable Diseases of Animals,* dictates the types of vaccines that should be used.

2-30. *Leptospirosis.* Leptospirosis in dogs is an acute, infectious disease which is transmissible to man. A spirochete organism of high motility (spontaneous movement) is the cause of the disease. This bacteria may exist for many months on dead or decaying organic material in rivers, lakes, ponds, or other bodies of water. Garbage, cesspools, and fish ponds may become contaminated with urine from infected animals and serve as a bearer of the disease. Infection usually results from entry of the organism through the mucous membranes of the nose or mouth. Less frequently, the organism enters through skin abrasions or through the genitalia during breeding activity. Leptospirosis is more prevalent in male dogs because they smell and lick areas possibly contaminated by urination of other dogs more frequently than do females.

2-31. The disease may attack suddenly after an incubation period of 5 to 15 days, with initial body temperatures reaching 103°F. to 105°F. Weakness, loss of appetite, vomiting, and mild congestion are among the early signs. Because these symptoms are not definitive, clinical diagnosis in this stage is extremely difficult. Other symptoms that may follow the initial infection are a decrease in temperature, hemorrhages of the skin and mucous membranes, jaundice, and muscular soreness. The disease establishes itself primarily in the liver and kidneys, and causes partial or complete loss of function of these organs.

2-32. Although the disease is extremely serious, mortality of dogs from leptospirosis seldom exceeds 10 percent of those infected. Antibiotics given early in the course of the disease may effect a cure. Owners should be advised that they can reduce exposure of their dogs by confining them to their own premises and by keeping them leashed when in places frequented by other dogs. These precautions are particularly important, because even those animals that recover from this disease may continue to shed the organism in their urine for some time.

2-33. *Ringworm.* A common zoonotic disease that infects the skin, hair, and nails of dogs and cats is ringworm. The disease is not caused by a worm, as the name may imply, but rather by a fungus. The small spores which cause the disease can be easily passed from pets to their owners as the owners pet and fondle them. The infection starts in the outer layer of the skin. From there, the organism grows in a threadlike manner about halfway down the hair follicles. At this point it enters the hair and grows back to the first layer of skin. Additional spores are produced in rows around the hair. The lesion then spreads in a circular manner from the initial point of infection; thus, the name "ringworm."

2-34. The appearance of ringworm is variable. In some cases, no lesions are apparent; only a few broken hairs may be evident. In other cases, the lesions may appear as circular, scaly patches with broken stubs of hair. In more severe cases, large areas of the body may become bald with crusted lesions that are filled with pus around the edges.

2-35. A definite diagnosis of ringworm is difficult to make merely from the appearance of the lesion. However, the veterinarian can identify the disease-causing organism by direct microscopic examination of hairs or lesion scrapings, or by a laboratory culture of the scraping. Infected hairs of one type of ringworm infection will fluoresce when exposed to ultraviolet light. Be careful to avoid infection when you are collecting and preparing the scrapings and hairs for examination under the microscope.

2-36. The veterinarian must direct medication. Complete recovery may require several weeks of treatment. Antifungal dips and shampoos may be used to prevent spread of the infection to other parts of the body or to other animals or to man. Clip the hair in the infected areas because active fungal elements may remain on and in infected hairs even after recovery is apparent.

2-37. **Communicable Diseases That Are Not Zoonotic.** We will discuss two of the contagious diseases which frequently attack dogs—canine distemper and infectious canine hepatitis. We will also describe the characteristics of feline distemper and feline pneumonitis, two of the most dreaded diseases of cats.

2-38. *Canine distemper.* Canine distemper is a virus disease which has been called the "scourge of dogdom," because it causes the death of more dogs than any other disease. It is highly contagious and its initial effects on a dog are similar to those of influenza on man. If you suspect that a dog has distemper, be sure that you isolate it at once. Then, thoroughly disinfect its runs, sleeping quarters, and feeding utensils with an agent that is effective against viruses.

2-39. You can often diagnose a typical case of distemper without great difficulty; however, in the initial stages you can easily confuse it with infectious canine hepatitis or with leptospirosis. The most evident symptoms of distemper are: mucous discharge from the nose and eyes, loss of appetite, depression, coughing, rise in temperature initially and after secondary infection, and convulsions or "distemper fits." You are always wise to suspect distemper in sick puppies that come from dog pounds or kennels.

2-40. The virus of canine distemper is practically always present in dog populations. For this reason most dogs are exposed to the disease early in life, unless they are raised in a completely isolated environment. Unless they are properly immunized, the probability of being infected is extremely high. Transmission of the disease can occur because of virus-containing droplets that are carried in the air, as well as by contaminated objects. Once an animal is exposed, the period of incubation is approximately 6 to 9 days.

2-41. An animal suspected of having canine distemper should be seen by a veterinarian as soon as possible. Even with immediate attention, there is no specific cure for the disease, because it is caused by a virus and does not respond to antibiotics. Therefore, you can contribute most to a satisfactory recovery by assuring that good nursing care is provided. Of utmost concern is that the dog continues to eat, which at times may require hand feeding. If the dog does not eat, it loses strength quickly and becomes more susceptible to secondary infections. By being in good condition the dog stands a better chance of recovery.

2-42. *Infectious canine hepatitis.* Another highly contagious virus disease of dogs, infectious canine hepatitis, may attack dogs of all ages; most often, however, young animals are affected. It may be spread from animal to animal through contaminated feeding and drinking utensils, direct physical contact, urine, houseflies, or dirt. The early symptoms of infectious canine hepatitis are difficult to differentiate from those of distemper. Animals are sometimes infected by the viruses of both infectious canine hepatitis and distemper at the same time, making diagnosis even more difficult. As the disease progresses, there may be icterus (yellow color) of the sclera and conjunctiva of the eye, if the liver and bile ducts are affected.

2-43. Hepatitis in dogs varies from mild cases of only a slight fever to illness that results in death. It is estimated that over 80 percent of all dogs have been exposed to the disease by the time they are a year old. The first sign of infection, after an incubation period of 6 to 9 days, is a rise in temperature to about 104° F. Often this initial temperature rise is followed approximately a day later by a drop to normal for a similar time. A second rise then follows and is sustained until recovery or death. The general symptoms include the display of a lack of emotion (indifference), a loss of appetite, an increased thirst, and the inflammation of the membranes of the eyes and nose. Vomiting is also a sign but a rather indefinite one unless it can be considered in connection with other more conclusive symptoms.

2-44. A dog that exhibits the signs and symptoms of infectious canine hepatitis should be examined and treated by a veterinarian as early as possible if recovery is to be expected. When the disease exists, the veterinarian will be able to detect a condition which interferes with clotting of the animal's blood. Prolonged bleeding time may make control of hemorrhages difficult. When the treatment results in a period of recovery, the animal may eat well but regain lost weight slowly. Of the dogs that recover, approximately 25 percent develop transient opacity of the cornea of one or both eyes.

2-45. *Feline distemper.* Like canine distemper, feline distemper is a highly contagious disease. It is caused by a virus which attacks principally members of the cat family; the raccoon is the only species outside the cat family known to be susceptible. The disease is known by such other names as feline panleucopenia, cat plague, feline infectious enteritis, and cat fever. Sometimes the disease appears to be seasonal. However, its incidence is more nearly related to the number of susceptible animals in the region. In other words, any increase in the cat population of a particular region may be accompanied by an outbreak of feline distemper. You should suspect any cat that shows generalized evidence of illness and fever of having distemper. The veterinarian should examine the suspected animals as soon as possible.

2-46. Infected animals can spread the disease rapidly because all their secretions and excretions contain the virus. The infection is spread through direct contact or by virus-contaminated materials or equipment. The incubation period varies from 4 to 10 days. Infection by the virus initiates a fever. The animal will then lose its appetite, vomit, and become depressed and weak. Diarrhea, rapidly causing extreme dehydration, may occur approximately 2 to 4 days after the initial temperature rise. A drastic drop in the white blood cell count is evident. The disease will usually run its course in approximately a week. Of the cases of feline distemper, 60 to 90 percent of the animals affected may be lost, with kittens being particularly difficult to save.

2-47. Do not give medication orally during the early treatment because vomiting will prevent effective action. The course of treatment should attempt to correct dehydration, provide nutrients, and prevent secondary infection. The veterinarian will perform treatment and prescribe medication to correct blood conditions of the infected animals. Cats that recover from the disease are immune thereafter.

2-48. *Feline pneumonitis.* Feline pneumonitis is one of a group of highly contagious respiratory infections. Characteristics of the disease include sneezing, inflammation of the mucous membrane of the nose, the secretion and flowing of tears from the eyes, and inflammation of the membranes of the eyes. Transmission of the virus of feline pneumonitis occurs naturally in droplets in the air. Incubation requires from 6 to 10 days. Infection of a cat may cause an initial temperature rise to 105° F. before it subsides to fluctuate between normal and 103° F.

2-49. Pneumonitis is more severe in young kittens. In many adult cases it may be limited to sneezing, a slight inflammation of membranes, and serous discharges from the nose or mouth. It may run its course in 5 to 10 days in milder cases, but may persist for 3 to 6 weeks when severe. Because the mortality rate for this disease is quite low, an infected animal's chances for recovery are usually good. However, the owner should realize that a prolonged illness will result in weight loss and other general complications which contribute to a weakened condition. Apparently, the virus can exist in a cat for long periods and all signs can reappear rapidly in the animal if it is placed under stress.

2-50. You can make a presumptive diagnosis on the general signs of sneezing, fever, inflammation of membranes, and serous discharges. For a definite diagnosis that will guide positive treatment procedures, refer the animal to the veterinarian. The best protection against infection of a cat with feline pneumonitis is to avoid exposure to sick cats, overcrowding, and stress.

2-51. **Noncommunicable Diseases.** There are a number of diseases which frequently affect small animals by causing inflammation in certain portions of the body. Although these diseases are not transmitted from one animal to another, they often occur as extensions of, or secondary infections with, communicable diseases. This condition makes positive determination of the cause of these diseases complicated and difficult. We will consider those noncommunicable diseases which cause inflammation of the skin or the membranes of the eyes, ears, gums, stomach, and intestines. These diseases are dermatitis, conjunctivitis, otitis, gingivitis, and gastroenteritis.

2-52. *Dermatitis.* Dermatitis is inflammation of the skin. Skin conditions that exhibit the characteristic signs of this disease vary rather widely and may include redness due to congestion of capillaries; the presence of excessive fluids as indicated by blisters, weeping, and excretions; small elevations of the skin that are solid, or are filled with pus or lymph; and scale or crust formations. Dermatitis may be produced by a variety of external irritations. However, it often occurs without the apparent existence of any irritant. In these instances, anything in the animal's environment can be suspected. The unseen irritant is often one of an exceptionally large number of allergens that can produce dermatitis. Exposure to certain light rays can also result in irritations that develop the disease. In addition, dermatitis may develop in some animals because of hereditary traits.

2-53. Evidence of itching, as indicated by scratching, calls first attention to infections of the skin. When this occurs, refer the animal to the veterinarian, who will determine the proper treatment. Elimination of the cause when it is apparent, will usually result in recovery. Clipping the hair in the affected area may promote satisfactory treatment. Sedatives can be administered, and protective collars and hobbles may be applied to prevent the animal from self-inflicted irritation as a result of scratching and licking.

2-54. *Conjunctivitis.* The delicate membrane that lines the eyelid and covers the front of the eyeball is the conjunctiva. Inflammation of these membranes is called *conjunctivitis.* When the conjunctiva is affected, various signs will be exhibited according to the cause of the inflammation. The observable symptoms include swelling, redness, and discharge containing watery secretions or pus. The disease can occur in one eye only, or in both.

2-55. Conjunctivitis may be caused by bacteria, viruses, foreign material, and chemical agents (soaps, fungicides, etc.) Treatment must first be directed toward removal of the causative agent. In order for the veterinarian to identify the cause correctly, he should examine the animal as early in the development of the disease as possible. Frequent cleansing of the affected membranes with appropriate solutions, as prescribed by the veterinarian, promotes recovery in most cases. Generally, animals suffering from conjunctivitis will be more comfortable and healing will be more rapid if they are placed in a darkened area. Sedation and restraint are sometimes required to prevent self-injury.

2-56. *Otitis.* Of the diseases which affect small animals, it is possible that those of the ear occur most frequently. Otitis is one of these diseases. The most common otitis (otitis externa) is an inflammation of the skin within the ear canal. The disease is more common in dogs than in other domestic animals. The breeds of dogs, with hanging ears and longer hair seem more susceptible.

2-57. An animal with otitis usually exhibits restlessness, and may scratch or rub its ears. It may also shake its head or may incline it to the affected side. The original infection may be aggravated by a secondary condition brought on by scratching, rubbing, and head shaking. Examination of the ear will usually reveal reddened skin and a yellowish discharge.

2-58. Treatment of the ear should be attempted only by a veterinarian. It may be necessary to clean the ear if the infection causes an accumulation of dried exudate. The cleaning must be done very gently to prevent further injury. In general, conservative treatment is desirable because overtreatment often results in unnecessary probing and swabbing.

2-59. *Gingivitis.* Most diseases of the mouth can cause gingivitis by spreading inflammation to the gums. Other causes include the secondary action of systemic diseases, physical injury, foreign bodies,

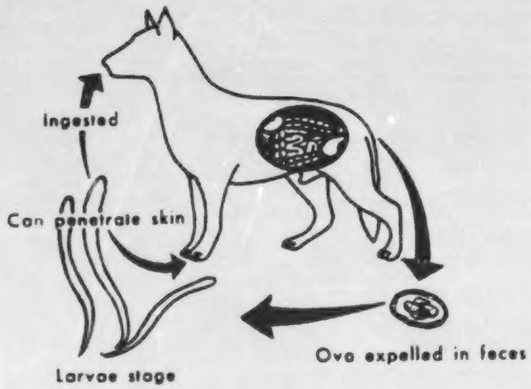

Figure 10. Life cycle of hookworm.

and dental caries. However, the most common cause is the accumulation of calculus deposits on the neck of the teeth.

2-60. Gingivitis can be recognized by bright red, inflamed gingival tissue surrounding the base of the teeth. The gums become swollen and ulcerated in more advanced cases, and they may bleed easily. Because an inflammation may be caused by a more serious condition, do not accept these signs as conclusive for diagnosis. Instead, the animal should be examined by the veterinarian so that proper treatment can be applied.

2-61. In any case, oral hygiene in the form of mouthwashes is a proper treatment. Where the infection is secondary, of course, the treatment must be directed toward the primary disease. If calculus deposits or dental caries are the cause of gingivitis, they must be removed by the veterinarian.

2-62. *Gastroenteritis*. Gastritis and enteritis are diseases which involve inflammation of the mucous membranes of the stomach and small intestine, respectively. These diseases may occur separately, but often both the stomach and small intestine are affected simultaneously. When this is the case, the disease is properly referred to as gastroenteritis. While gastroenteritis is associated with infectious diseases such as distemper, hepatitis, and leptospirosis, it can also be caused by overeating, spoiled food, indigestible food, or irritating drugs or chemicals.

2-63. Vomiting is the most common sign of inflammation in the stomach, while diarrhea is usually evident with inflammation in the lower intestine. These conditions are often accompanied by pain as indicated by restlessness of the animal and its reaction to pressure applied to the abdomen. Severe infections of gastroenteritis may cause the vomitus to contain blood. If bleeding occurs in the upper portion of the small intestine, the feces may be dark green or black; bleeding in the lower portion will give a blood-streaked appearance. Also, the feces may be watery and exceptionally foul smelling.

2-64. Treatment of this disease must be as directed by the veterinarian. In addition to any medication that he may prescribe, he will usually change the animal's diet. All food and water can be withheld for as much as a day. The animal's thirst can be controlled by allowing the animal to lick ice cubes. When the animal is again allowed to eat, only such foods as boiled milk or broth are first included in the diet. This diet is gradually changed, using bland foods like oatmeal, soft-boiled eggs, and cooked rice and milk puddings until the animal returns to normal.

2-65. **Parasitic Diseases.** Many common diseases of small animals are caused by parasites. These parasites are of two general types: endoparasites and ectoparasites. The endoparasites are those which live within the body of the host (animal) and include hookworms, roundworms, whipworms, heartworms, and tapeworms. Ectoparasites live on the outside of the body of the host. Ticks, mites, lice, and fleas are ectoparasites which infect small animals.

2-66. Small animals infected by internal parasites do not usually demonstrate well-defined signs, except when the disease is in an advanced form. However, there are observable conditions which indicate the need for more extensive examination of the animal by a veterinarian. These conditions include unthriftiness, dull haircoat, changeable appetite, weakness, loss of weight, vomiting, diarrhea, and anemia (pale mucous membranes).

2-67. A definite diagnosis of these diseases can be made by identifying the parasite or its eggs. In some cases, adult parasites may be found in the animal's vomitus or may be voided in its feces. Usually these adult parasites can be seen with the naked eye. However, the most consistent and reliable identification of parasitic diseases results from examining the feces or blood using a microscope.

2-68. *Hookworms*. Mature hookworms, which are usually found in the small intestine, may be approximately 1/2 inch long. The eggs, after being passed in the feces, undergo a series of changes in the environment and become infective larvae. Dogs may be infected in three ways: ingestion of infective larvae, penetration of the skin by infective larvae, or prenatal infection of puppies by migration of the larvae through the tissues of the mother. It is possible for dog hookworm larvae to penetrate the skin of humans. The disease in man is known as cutaneous larva migrans, or more commonly as "ground itch." The typical life cycle of the hookworm is shown in figure 10.

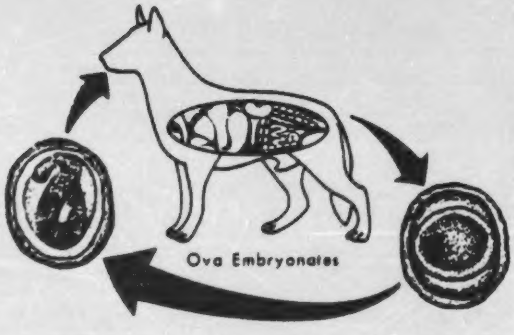

Figure 11. Life cycle of roundworm.

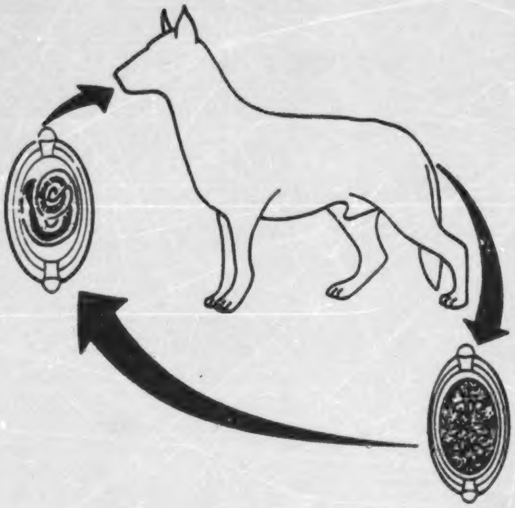

Figure 12. Life cycle of whipworm.

2-69. Once the parasite is identified, the veterinarian can prescribe effective treatment with drugs. Furthermore, preventing the development of larvae in the soil can aid greatly in the control of these parasites. This control can be accomplished by using chemicals and maintaining strict sanitation in the runs and kennel areas. However, handle these chemicals in strict accordance with directions—for the safety of personnel and animals.

2-70. *Roundworms.* Dogs and cats that are infected with roundworms pass eggs in their feces. These eggs undergo a series of developmental changes in the environment and become infective. Unlike the hookworm, they do not become free larvae until the eggs have been ingested. These larvae then penetrate the intestine and migrate to the liver and other body tissues, and end up in the lungs. Upon reaching the lungs, the larvae are coughed up and swallowed. The parasite then becomes an adult which localizes in the small intestine. Figure 11 shows the typical life cycle of the roundworm. As with hookworms, prenatal infection is possible by larvae migrating through the mother's tissue to unborn pups. With certain species of roundworms, dogs and cats may become infected by eating intermediate hosts, such as rodents. Roundworm infection of young animals may be extensive and therefore particularly serious. Lack of growth and potbellied development are indications of infection. It is possible for humans to become infected with dog and cat roundworms. This infection in man is called visceral larva migrans and may be quite serious when the migrating larvae localize in the nervous system.

2-71. A definite diagnosis of this disease is made upon detection of eggs in the animal's feces. Highly effective drugs are available to be used in treating roundworms when prescribed by the veterinarian. To prevent spreading the disease, repetition of the treatment may be required until no eggs are found in the feces. Feces should not be allowed to accumulate, but should be collected regularly and destroyed.

2-72. *Whipworms.* The anterior portion of the whipworm is long and slender while the shorter posterior portion is thickened. These worms firmly attach themselves to the wall of the intestine, usually the cecum where they grow to maturity. The adult whipworm may reach a length of nearly 3 inches. When an animal is heavily infected by whipworms, fresh blood may be seen in the feces, with anemia following. The life cycle of a whipworm can be seen in figure 12.

2-73. In addition to the medication prescribed by the veterinarian, the treatment of whipworms should include action to destroy the eggs and to prevent development of the larvae. The eggs are particularly susceptible to destruction by the drying action of desiccants. The infection of dogs can be greatly reduced by maintaining sanitary conditions where they are kept and by eliminating moist areas where the eggs and larvae may be harbored.

2-74. *Tapeworms.* The tapeworm is the longest of the internal parasites that ordinarily infect small animals. The length of these worms may exceed 2 feet and their appearance, as compared to the other worms that we have discussed, is flat rather than round. Infection by tapeworms is a greater problem with dogs which may occasionally eat animals, such as rabbits or rodents, that serve as intermediate hosts. Dogs that are fed prepared foods are susceptible only to tapeworms whose larval stage develops within the flea. The typical life cycles of dog tapeworms are shown in figure 13.

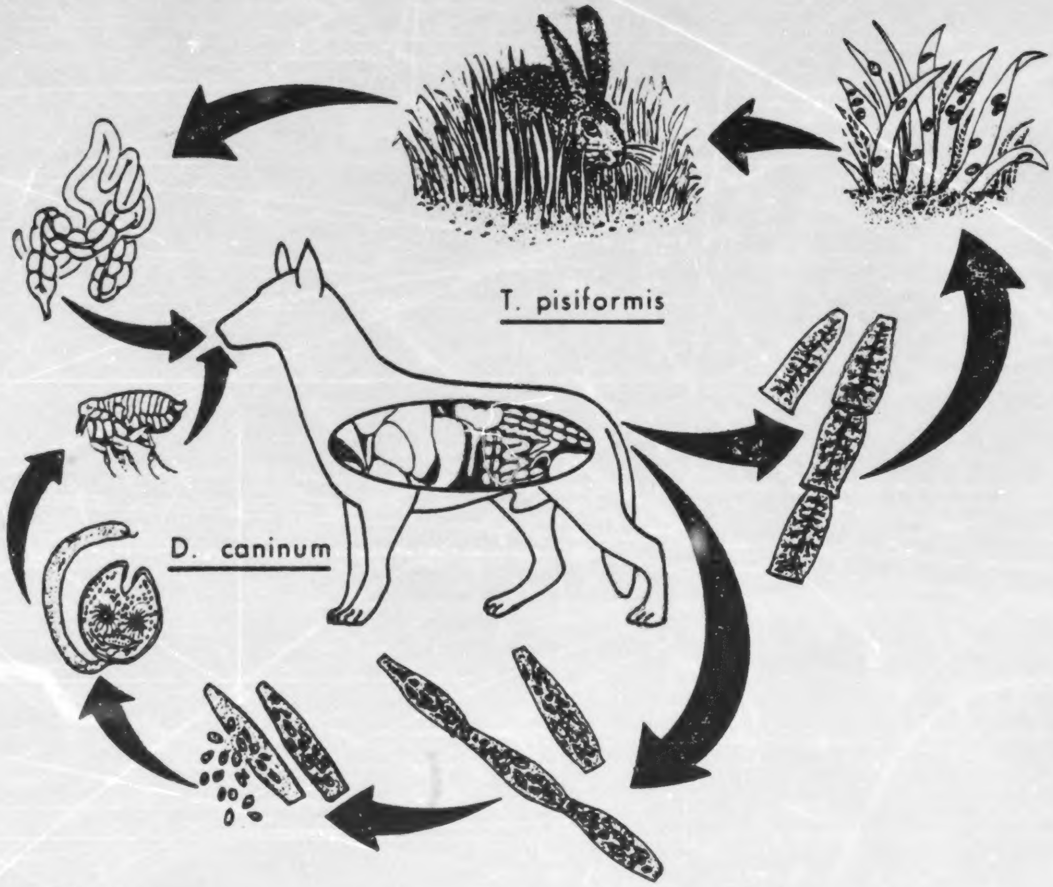

Figure 13. Life cycle of two tapeworms.

2-75. The signs of infection with tapeworms are those of general unthriftiness; however, the veterinarian can readily identify the proglottids (segments) of the tapeworm in the feces of the animal. He will be able to prescribe the necessary medication for treatment. Preventing reinfection can be particularly difficult where fleas are the intermediate host. Also, the ability of the head of a tapeworm to regenerate new segments makes their complete elimination more difficult.

2-76. *Heartworms.* The first evidence of infection of an animal with heartworm disease is usually either a chronic cough or rapid tiring. Although the worms mature and live in the right ventricle of the heart and the adjacent blood vessels, the pulmonary artery and the circulatory vessels of the lungs usually first reflect damage from the infection. Inflammation of the inside of the pulmonary artery and the lodging of dead worms is followed by the formation of fibrous tissue. These blockages result in increased blood pressure in the circulatory vessels of the lungs.

2-77. There are four stages in the life cycle of the heartworm: egg, microfilaria, larva, and adult. Approximately 8 months pass from the time the eggs develop in the uterus of the female worm until the adult worms reach maturity. At this time the female worms may become 10 inches long. Figure 14 shows the typical life cycle of the heartworm.

2-78. The microfilaria hatch from the eggs in the uterus of the female heartworm and are discharged into the bloodstream of the animal. From there, the microfilariae must be ingested by certain species of mosquitoes (intermediate hosts). The larvae then become infective within the insect's body. The larvae gain entry to the animal's body from the mouth of the mosquito when it feeds again. The larvae develop and grow into immature worms in the fatty tissues and muscles beneath the animal's skin. Finally, the cycle is completed when these

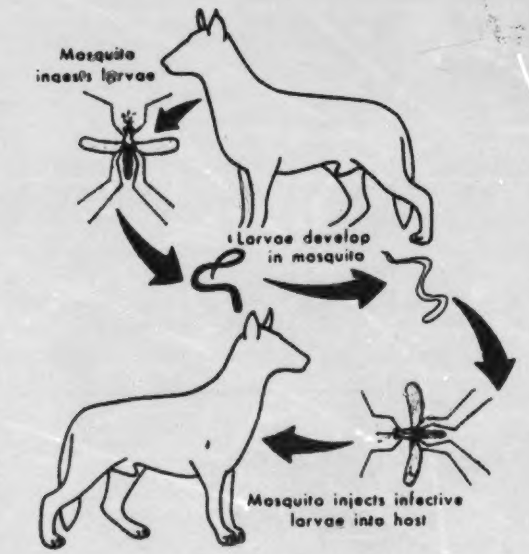
Mosquito ingests larvae
Larvae develop in mosquito
Mosquito injects infective larvae into host

Figure 14. Life cycle of heartworm.

worms enter the circulatory system and mature in the vicinity of the heart.

2-79. Because they are only about 300 microns long, microfilariae can be seen only with the aid of a microscope. If detection is to be assured, even when small numbers are present, we must concentrate the microfilariae, using the Knott's concentration test. Take a specimen of blood from a vein of the animal and mix the blood with formalin. Centrifuge the solution, pour off the supernatant fluid, and transfer the sediment to a slide. A drop of methylene blue, when mixed with the sediment, will dye (color) any microfilariae that are present and make them easier to see.

2-80. The microfilariae of the heartworm can be identified by examining the prepared slide. Drugs are available for successful treatment of both the adult heartworm and the microfilariae. Pets can be protected from infection, to some extent, by keeping them in screened quarters at times when mosquitoes feed most actively. A very important factor in the control of heartworm disease consists of reducing the mosquito population in the area. When dogs must work where heavy infestations of mosquitoes prevail, apply a repellent to their haircoat.

2-81. *Ticks.* Like all external parasites, ticks feed upon the blood of small animals. While biting and burrowing their heads into the animal's skin to engorge upon blood, they cause local areas to become irritated and infected. The condition of these irritated areas becomes further aggravated as the animal rubs, scratches, licks, and bites to rid itself of the ticks. In turn, these raw and bleeding sores can develop secondary infections.

2-82. Most of the ticks that infect dogs are of the three-host type. In other words, they may live on the blood of three different animals during the stages of their development. After the adult ticks mate on the first host, the blood-engorged female drops to the ground to digest the blood and lay eggs. In about 2 weeks, the eggs hatch into 6-legged larvae, or "seed ticks." The seed tick may exist a considerable length of time without feeding but must obtain a meal of blood if further development is to take place. Once the seed tick becomes engorged on the blood of the host, it drops again to the ground, where it molts and becomes a nymph. The nymph, which is larger than the seed tick and has four pairs of legs, can survive several months before requiring blood from a second host. Upon becoming attached to and filled with the second host's blood, the nymph falls again to the ground. There, it molts, becomes an adult, and returns to some vegetation, where it awaits the third and final host. On the final host, mating occurs and the female drops to the ground to lay eggs, completing the cycle, which is shown in figure 15.

2-83. The first noticeable evidence of infection with ticks is the animal's efforts to dislodge them. An animal's head shaking and scratching actions should be reason enough to make a close examination. If there are any ticks on an animal, you can find them usually in the area of the ears, neck, or flanks.

2-84. When the ticks are properly removed from an infected animal, any irritated skin areas usually heal rapidly without further treatment. There are several satisfactory dips, dusts, and sprays that the veterinarian can prescribe for use in removing the ticks. Once the ticks are removed, he can determine if further treatment is necessary. Of course, treatment of the animal without regard for infestation of the premises would be of limited

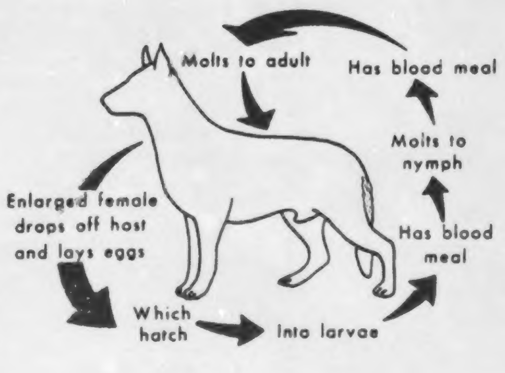

Figure 15. Life cycle of tick.

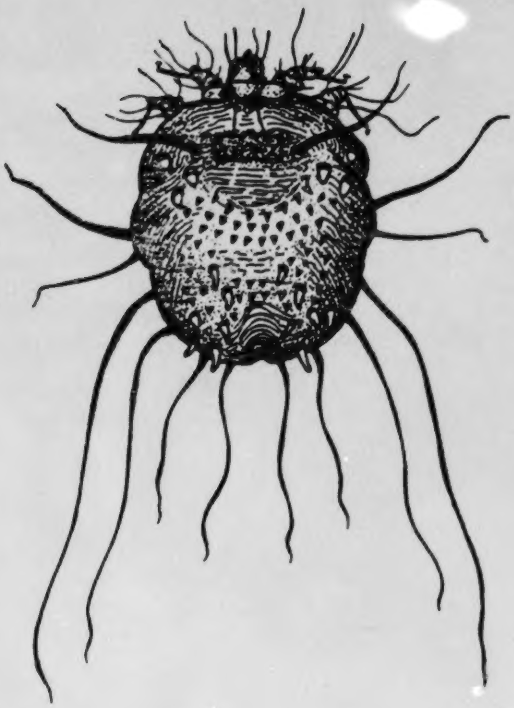

Figure 16. *Sarcoptes* (female), mange mite.

effect. Often you must repeat the treatment of both the premises and the animal before the ticks are completely eliminated.

2-85. *Fleas.* Both dogs and cats are common hosts of fleas. Much of the adult life of the flea is spent on the body of one of these animals where it can readily feed on its blood. However, the eggs usually hatch into larvae where they are laid or where they fall from the host. The larvae can develop by feeding on organic material existing in the bedding of the host or in cracks and crevices of the housing or premises. The mature larvae spin a cocoon about themselves and, after about a week, the adult flea emerges from the cocoon.

2-86. In addition to the irritation caused by their biting, fleas also secrete saliva products which have toxic or allergenic effects on the animal's skin. If the animal's skin is hypersensitive, intense itching results. As the animal scratches the itching areas, further self-inflicted irritation is produced. In this way a vicious cycle of irritation and itching is maintained.

2-87. As with tick infestation, discovery and identification must be the first steps in treating infestations caused by fleas. Fleas are usually found in greater numbers around the animal's head or near the base of its tail. Once fleas are located, the veterinarian can specify the proper topical or oral preparations to rid them from the animal and its environment. With the fleas eliminated, the veterinarian can determine and prescribe treatment necessary for relieving the irritation and controlling any secondary infection.

2-88. *Lice.* Either sucking or biting lice may infest dogs or cats. The mouth parts of those which suck blood resemble probes, while the biting lice have definite, movable, chewing mandibles. For this reason, biting lice are able to live on products of the outer layer of skin in addition to blood. Lice multiply rapidly; less than a month is required for a complete generation to reproduce.

2-89. The haircoat of animals that are "lousy" is dry and rough, and it can become matted if the infestation is heavy. When inspecting an animal for the presence of lice, always part the hair in these matted areas and make a close examination. You can see biting lice moving through the hair, while you will find sucking lice with their mouth parts imbedded in the skin. If you find pale, translucent, suboval eggs glued onto the animal's hair, adult lice are undoubtedly present too.

2-90. Most lice are transmitted by direct contact of the host animals. Therefore the most effective control methods are first concerned with eliminating the lice on the animal. As with ticks and fleas, the veterinarian can select a good chemical insecticide and prescribe the best method for

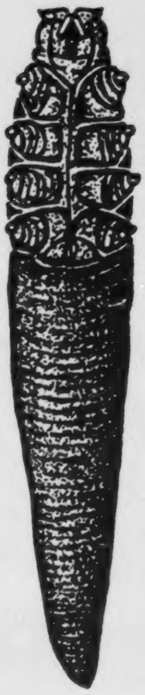

Figure 17. *Demodex canis,* mange mite.

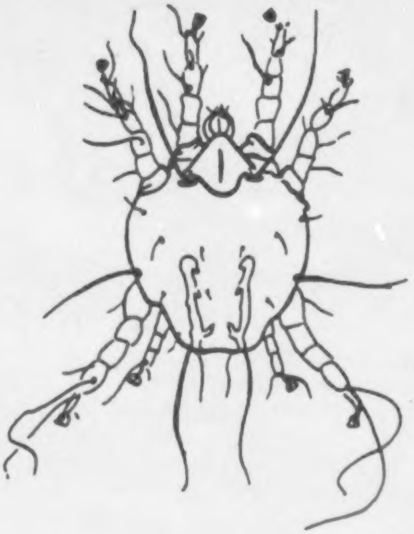

Figure 18. *Otodectes*, ear mite.

applying it to the animal. Lice can exist for little more than a week after becoming detached from a host. However, premises that were previously occupied by lousy animals can continue to be infested by the hatching of ova for nearly a month. For this reason, disinfect quarters that have been recently occupied by infested animals before they are used again.

2-91. *Mange mites.* Mange, a contagious skin disease of small animals, is caused by mites. Primarily you will see two types of mange mites on dogs and cats that are brought into the clinic for treatment: the *Sarcoptes* mite, which has a circular body with four pairs of very short legs (fig. 16), and the *Demodectes* mite, which has an elongated body with four pairs of legs near the anterior end (fig. 17). The *Sarcoptes* mite, which burrows into the skin, causes a mange characterized by itching, hair loss, thickening and wrinkling of the skin, and in advanced cases, secondary bacterial infection. *Demodectes* mites cause mange, often called *red mange,* characterized by reddening and itching of the skin, hair loss, and often, a secondary bacterial infection. The lesions of both types of mange usually appear first around the eyes, lips, ears, or on the paws, before spreading to the neck and body.

2-92. Diagnosis is usually a simple procedure; treatment, however, can be quite difficult at times. Diagnose the disease by deep skin scrapings to remove the mites for microscopic examination and positive identification. Treatment of *Sarcoptic* mange is rather easy with the use of insecticidal dips. *Demodectic* mange, on the other hand, can be very difficult to treat, so much so that some dogs never recover. There are a number of treatments, both external and internal, available for use.

2-93. *Ear mites.* The ear mite, *Otodectes,* as seen in figure 18, invades the ear canals of dogs and cats and causes a condition characterized by irritation in the ears and a buildup of a dark brown tarlike substance giving off a foul odor in the ears. Dogs suffering from ear mites often shake their heads and scratch and paw at their ears.

2-94. You can diagnose ear mites by microscopic examination of the material swabbed out of the ears with cotton swabs soaked in mineral oil. Treat the animal by administering any of a variety of insecticidal solutions or creams into the ear canal.

2-95. Although this discussion of the diseases of small animals has been limited in scope, the information included should be helpful to you as you assist the veterinarian. Remember, it is not intended that you perform his duties, but you can certainly make his efforts more effective if you become capable of recognizing some of the more important signs of the common diseases.

MODIFICATIONS

Chapter 2 of this publication has (have) been deleted in adapting this material for inclusion in the "Trial Implementation of a Model System to Provide Military Curriculum Materials for Use in Vocational and Technical Education." Deleted material involves extensive use of military forms, procedures, systems, etc. and was not considered appropriate for use in vocational and technical education.

CHAPTER 3

Fresh Fruits and Vegetables

NUTRITIONALLY speaking, the fresh fruits and vegetables purchased by the Armed Forces are quite a bargain: an investment in good health. The reason is that each day these foods supply high percentages of the body's nutritional requirements: protein, 13 percent; carbohydrates, 15 percent; minerals, 52 percent; vitamin A, 58 percent; vitamin B, 48 percent; and vitamin C, 92 percent. The quality and freshness of these products, as well as the techniques used in their handling, directly affect the nutrient content. Part of your job will be to determine whether the fresh fruits and vegetables delivered to your base are fresh, of good quality and condition, and are being handled in the proper manner.

2. Your responsibilities concerning fruit and vegetable inspection will vary depending on the base to which you are assigned. Rest assured, though, that all bases have some fruit and vegetable inspection requirements. We will cover many aspects of fresh fruit and vegetable inspection in this chapter, including the methods used by the Government to purchase produce, the inspection criteria and steps used in performing the various classes of fruit and vegetable inspections, the factors that influence the storage life of fruits and vegetables, the grades of produce, and some condition factors peculiar to the major fruits and vegetables purchased by the Government.

3. Before you can completely understand the principles of proper fruit and vegetable storage or the criteria for their inspection, you need some knowledge of the physiology of plants. Therefore, we will begin our chapter with a discussion of the physiological processes of the plants and plant parts that we call fruits and vegetables.

6. Physiological Processes of Plants

6-1. In this section we will look at several life processes characteristic of plants and plant parts (fruits and vegetables) in order to understand the changes they undergo, the requirements for their proper storage, and the observable criteria on which their inspection is based. We will discuss photosynthesis, transpiration, respiration, maturity, and ripeness.

6-2. **Photosynthesis.** Photosynthesis is the means by which plants, with the use of sunlight, manufacture certain essential chemical compounds. Chlorophyll, a pigment in the green parts of plants, traps sunlight and uses the solar energy for combining water, absorbed by the roots, and carbon dioxide from the air to produce a simple sugar and oxygen, which is given off as a gas. Most of the sugar is converted into starch (carbohydrate) which is then stored for use as food for the plant. Transport tissues carry much of the sugars and carbohydrates to various storage positions within the plant, for example, the tubers of potatoes and the edible tissues of fruits, such as apples or pears.

6-3. **Transpiration.** Transpiration is the process by which excess water, which was absorbed through the roots, is given off through pores (stomata) in the leaves.

6-4. **Respiration.** The thousands of cells that make up the plant or plant part that we know as a fruit or vegetable carry on living processes. Through the process of respiration the cells break down carbohydrates to liberate stored energy necessary for life. The compounds they break down (oxidize) are those that were produced in the leaves by photosynthesis. This respiratory process continues after the fruit or vegetable is harvested. As it continues, heat is released and carbon dioxide and water are formed. The speed of the reactions that take place during respiration varies with the type of plant and the temperature. The lifespan of a vegetable or fruit (after harvesting) is dependent upon the speed, or rate, of these respiratory reactions. Temperature is a factor in controlling the rate of respiration, and proper storage temperatures (36° F. to 38° F.) prolong product life by slowing down the rate of respiration.

6-5. **Maturity.** Maturity is reached at the point where growth ceases, the seeds are fully developed, and the item is at the stage of development where the ripening process will ensue. Practically speaking, maturity is relative. Different fruits and vegetables have different maturity requirements that relate to their use and acceptability.

6-6. **Ripeness.** A fruit or vegetable is "ripe" at the stage of development when enough of the starches have been converted into sugar to make the product fit for use. The flesh ordinarily yields to moderate pressure and the product is in prime eating condition. We will discuss maturity and ripeness later when we discuss the factors that determine the quality and condition of fresh fruits and vegetables.

7. Storage of Fresh Fruits and Vegetables

7-1. The proper storage of perishable fruits and vegetables extends their life and is essential to:

a. Allow distribution before spoilage.
b. Provide seasonal items for longer periods.
c. Retain surplus items for times of shortage.
d. Provide items in geographical areas where they are either short or nonexistent.

This extension of life is accomplished by controlling the temperature and, to a lesser extent, the atmosphere. When you attempt to control the temperature, you should know how different temperatures affect various fruits and vegetables. Cold is the absence of heat, so temperature control (refrigeration) is nothing more than removing heat.

7-2. **Heat Effects.** The enzymes contained within living organisms bring about changes in color, texture, and chemical composition after harvest and throughout storage. These changes generate internal heat which hastens ripening and ultimate deterioration. In your job, you must be aware of three types of heat and their effects on shipping, storage, and distribution of fruits and vegetables: field, vital, and container.

7-3. Field heat is externally generated heat. Its fast removal favorably sets the color, flavor, and texture, and also retards enzymatic action. Preferably, it is removed as soon as possible after harvest, sometimes during field packing. Two methods of removing field heat are: (1) hydrocooling (ice and water) at the packing shed, and (2) vacuum cooling in the shed, car, or crate.

7-4 Vital (latent) heat is produced as a byproduct of respiration and other chemical changes during transportation and storage. Experts use this heat to determine the relative temperature and humidity requirements for different species. For instance, peaches, lettuce, and peas generate more vital heat because they have higher respiratory rates, while potatoes, onions, and apples generate less vital heat because of lower respiratory rates. Ways of decreasing vital heat and slowing respiration include refrigeration, waxing, wrapping, and harvesting at a less advanced stage of maturity.

7-5. Container heat is that acquired from the actual container material, from the interior surfaces of the warehouses and transport vehicles, and from the surrounding atmosphere. This ambient temperature must be carefully controlled in refrigeration and storage holding. Lowering storage temperatures retards the growth of bacteria and fungi and slows respiration and ripening. Raising storage temperatures has the opposite effect; an increase of 18° F. will approximately double the respiratory rate.

7-6. **Storage Practices.** If the storage life of fresh fruits and vegetables is to be lengthened, the plant's rate of respiration must be slowed. The slowing down of respiration is accomplished by controlling the heat through refrigeration, controlling the humidity, and possibly controlling the atmosphere.

7-7. Each fruit and vegetable species has an optimum storage temperature; however, most fruits and vegetables can be safely stored at 32°F., while some must be held at about 45°F. We will look at specific temperature requirements later. The storage temperatures should not fluctuate. Fluctuation results in increased evaporation at high temperatures followed by condensation at low temperatures. This robs the produce of water, leaving items in a shriveled and unpalatable state. Although freezing temperatures retard the growth of fungi and bacteria, slow respiration, and slow the ripening processes, certain fruits and vegetables are seriously injured by such low temperatures. A fall of 2°F. or 3°F. below freezing may injure plant tissue and make the product unfit to eat. For instance, incompletely ripened tomatoes, though mature, will develop a water soft rot rather than ripen if stored at improper temperatures. A typical vegetable retains its essential sweetness for only 1 day when stored at 80°F. but for 14 days when stored at 40°F.

7-8. You are expected to recognize the results of malpractices in refrigeration. Some objectionable outcomes of improper heat control are as follows: Potatoes stored for a few weeks at temperatures below 40°F. develop a sweet taste because of enzymatic action which converts the starch to sugar. Fried potatoes and potato chips made from such potatoes will have a dark brown color. Cucumbers usually develop pits and dark, watery areas if held 10 days or longer at 45°F. Summer squash develop severe pitting in about 8 days if stored at 32°F. to 45°F. Under similar conditions, unripe melons undergo definite damage. Honeydew melons, cantaloupes, eggplant, and sweet peppers all may show chilling injury. Some of the subtropical fruits (such as pineapples, bananas, avocados, and olives) are also susceptible to chill injury. Grapefruit and lemons may develop abnormal skin or flesh if stored for several weeks at temperatures below 50°F.

7-9. Heat and humidity are closely related in their importance in storage. Humidity is a general

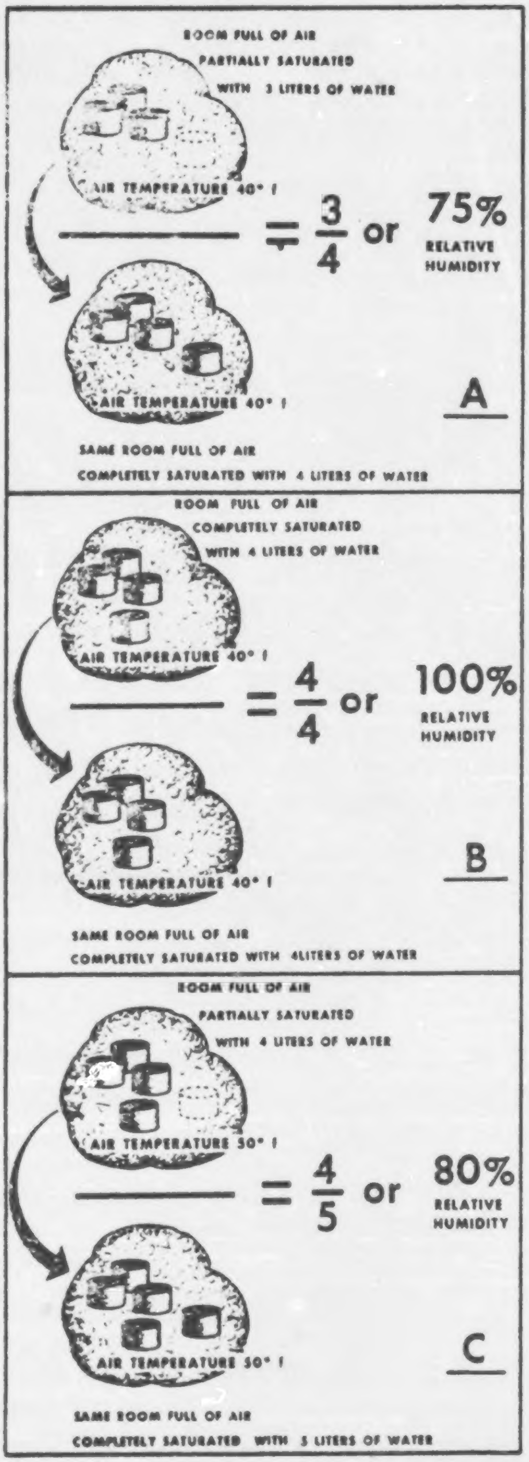
ROOM FULL OF AIR
PARTIALLY SATURATED
WITH 3 LITERS OF WATER
AIR TEMPERATURE 40° F
= 3/4 or 75%
RELATIVE HUMIDITY
AIR TEMPERATURE 40° F
A
SAME ROOM FULL OF AIR
COMPLETELY SATURATED WITH 4 LITERS OF WATER
ROOM FULL OF AIR
COMPLETELY SATURATED
WITH 4 LITERS OF WATER
AIR TEMPERATURE 40° F
= 4/4 or 100%
RELATIVE HUMIDITY
AIR TEMPERATURE 40° F
B
SAME ROOM FULL OF AIR
COMPLETELY SATURATED WITH 4LITERS OF WATER
ROOM FULL OF AIR
PARTIALLY SATURATED
WITH 4 LITERS OF WATER
AIR TEMPERATURE 50° F
= 4/5 or 80%
RELATIVE HUMIDITY
AIR TEMPERATURE 50° F
C
SAME ROOM FULL OF AIR
COMPLETELY SATURATED WITH 5 LITERS OF WATER

Figure 31. Effect of water on relative humidity.

term descriptive of wetness, or the moisture content of the air. Relative humidity is the ratio (expressed as a percentage) of water vapor actually present in air compared to the greatest amount of water vapor possible in the same air at the same temperature. Thus a relative humidity (RH) of 100 percent expresses an atmosphere that is completely saturated (fig. 31).

7-10. Each degree of temperature change affects the relative humidity—the capability of the air to hold more or less water at the new temperature. A rising temperature increases both the rate of evaporation and the capacity of the air to hold water. As the temperature rises, more water evaporates from the plant. This evaporation (or drying out) affects the quality of fruits and vegetables during storage. It can cause a loss in weight or a change in the texture, as evidenced by shrinkage or wrinkling. The rate of evaporation is affected by the relative humidity of the atmosphere in the storage room. On the other hand, if a saturated atmosphere cools, condensation occurs, and the water, once lost, is not reabsorbed by the plant, but collects and establishes a breeding place for unwanted mold and bacteria.

7-11. There is no particular relative humidity that is optimum for the storage of all fresh fruits and vegetables. Generally, leafy green vegetables require a high RH, 90 to 95 percent. White onions, garlic, melons, and squash need a lower RH, 70 to 80 percent. Most other fruits and vegetables store well at 80 to 90 percent RH. A good rule of thumb is to maintain a humidity equal to or slightly above the normal moisture content of the product, somewhere between 80 and 98 percent. AFM 145-1, *Commissary and Subsistence Depot Operating Manual*, provides information that will serve as a guide for the storage of fresh fruits and vegetables. The data in this manual are not to be used as hard-and-fast rules, but only as general guides.

7-12. A refrigerated room that is full of produce will usually maintain humidity at a satisfactory level. An almost empty room needs an additional source of moisture to overcome evaporation caused by refrigeration. Wet ice and water spray are methods that help. Since any solid object, to a degree, will collect or discharge moisture when sudden changes in temperature occur, ventilation is a necessary requirement to keep this moisture in the air and off the product.

7-13. A relatively new storage practice is the controlling of the atmosphere to which the fruit or vegetable is exposed. "CA," as controlled-atmosphere is commonly called, originally was suited only to apples. CA is a process of replacing the oxygen in the atmosphere with inert gases. This replacement reduces the rate of respiration of the item and decreases degeneration. Some commodities benefit from low-oxygen atmospheres and have extended life, while other items are harmed and their storage life is reduced. By extending the life of a commodity, storage is prolonged, and the product can be transported farther and be distributed on markets that were previously inaccessible. The Navy uses CA in the storage holds of ships, thus providing the men afloat and abroad with fresh produce, which was previously not possible. The full potential is yet to be derived from CA. However, all products, as previously noted, do not respond equally to low-oxygen atmospheres, and some are not suited to this treatment.

7-14. Two principal techniques are used to reduce the percentage of oxygen in CA storage rooms. The first uses displacement of oxygen by carbon dioxide in the natural respiration of the fruit. In this process, however, provisions are made to prevent excessive accumulation of carbon dioxide, which could be harmful. The second method involves the circulation of an atmosphere of the desired composition (produced by commercial generators) through the storage rooms to replace normal air. By this method, the oxygen content is lowered sufficiently in a matter of hours, or at most a few days, much faster than by the first method.

7-15. Many fruits and vegetables have been tested in CA storage to determine the most suitable atmospheric conditions or temperatures for prolonging their life. As this is being written, the most successful CA storage is for apples. Each apple variety differs in oxygen, carbon dioxide, temperature, and RH required and some varieties have been successfully stored for 7 to 8 months at 38°F. CA allows growers and others, selling fruits and vegetables that are adaptable to CA, an extended period for marketing and more flexibility in choice of time to market.

7-16. Now that you have studied basic plant physiology and have also reviewed the principles of the storage of fresh fruits and vegetables, you are ready to take up the inspection of fresh fruits and vegetables.

8. Inspection of Fresh Fruits and Vegetables

8-1. **Inspection Criteria.** There are three inspection criteria with which you should be familiar—condition, quality, and grade. There is a definite distinction between these, and you should clearly understand the difference.

a. Condition—concerns such factors as decay, disease, and internal, unseen factors inherent to that particular product.

b. Quality—can be broken down into appearance, texture and flavor categories; quality includes such characteristics as maturity, freedom from insect damage, color, and surface blemishes.

c. Grade—when correlated to US standards, refers to the sum of the characteristics of the commodity at the time it is graded, including both quality and condition factors.

8-2. *Condition.* Since condition defects are of a progressive nature, the condition of fruits and vegetables is subject to change in transit or storage. Condition factors are divided into two categories—biological and physical. These factors are quite varied in nature, but all of them can reduce a product to very poor condition. You must continually be on the lookout for poor condition factors while performing an inspection of fresh fruits and vegetables; in many instances, condition will be your primary concern during an inspection. Let's look at biological and physical condition factors to see what causes poor condition in fruits and vegetables.

8-3. Biological factors are a result of living organisms and physiological processes. Bacteria and mold can cause the product to decay or rot. Remember, decay is progressive. Do not overlook decay because it is only in small spots on the fruit—after a time those spots will enlarge and render the fruit inedible. Insect damage is also an important condition factor. Most often insect damage is a readily noticeable condition; however, you must pay close attention to fruits and vegetables because sometimes a tiny hole in the skin will lead to a large area of damage on the inside. Never hesitate to cut open a few of the items in question to satisfy yourself that they are in good condition.

8-4. We have already discussed ripeness in the section on physiological processes. Now let's look at this factor as it relates to condition. You will recall that we said the physiological processes continue in fruits and vegetables after they are harvested. We must be well aware of this matter because it is the basis for many of our procurement and storage practices. We must take into consideration the fact that during the time between harvest and use, many products continue to ripen. Without considering this point, produce would be purchased in a ready-to-eat stage but would not be scheduled for use for several days or a week. The result would be a product that is overripe at the time of use. This problem is solved by buying products that have not yet reached the usable stage of ripeness. Then, during storage or shipment, the ripening process can continue; by the time the products are used, they will be at the desired stage. For example, tomatoes and pears must be picked in a mature green state if they are to be consumed after any great time in storage.

8-5. There are many physical condition factors with which you will need to be familiar. They are caused by high and lows in temperature, chemicals, or rough handling. Heat injury (sunburn or scald) primarily affects apples, peppers, and tomatoes. A scarcity of leaves allows too much sun to penetrate and results in the damage. Another type of heat injury is caused by high temperatures during the washing process; for example, oranges so washed develop burnt and dried-out skins. On the other hand, in a low-temperature injury (chill or freeze damage), ice crystals form which crush cells and result in a loss of juice.

8-6. Another physical cause of condition defect is the improper use of chemicals during processing. The following chemicals are responsible for noticeable changes in appearance as stated:

a. Hydrochloric acid—light tan burns on the product's skin.

b. Sodium silicate—brown areas on the product's skin.

c. Sulfur dioxide—gray sheen on the product. (If excessively used for fumigation purposes.)

8-7. Of the physical factors, veterinary inspectors most commonly encounter mechanical injury or damage. Within this area, bruising (crate pinching and rough handling) is most frequent. Through bruising, cells are mechanically crushed; thus, the product's barrier to biological disease or to chemical damage is destroyed.

8-8. Condition defects may also occur in combinations. Consider penicillium rot (blue mold), a common biological disease that affects apples. The cells beneath the skin carry on their natural processes, even though the blue mold spores contaminate the skin. These spores are carried by the air. Under ideal conditions (temperature of 50°F. to 60°F. and high humidity) the spores germinate and grow, and within 4 to 5 hours, spread across the apple's skin surface. The growth causes little or no damage to the fresh apple itself, until mechanical damage occurs. Since food and moisture are available, a break in the skin implants the organism, and disease in the tissue ensues almost immediately. Under less favorable conditions, such as lower temperatures, the disease requires a longer time to establish itself. As the disease progresses, cells die and disintegrate and, thereby, release cell fluids. These cell fluids flood the spaces between adjacent cells and cause a water-soaked appearance as evidence of the ravages of rot. This water-soaked appearance requires 4 to 7 days to develop. A later development of the disease results in a drying out of the diseased tissues which then take on a brown appearance. In more advanced stages, the external mold can be seen with the naked eye.

8-9. There are many factors leading to the poor condition of fruits and vegetables, most of which originate from a combination of causes. The signs may vary, but rough handling and bruising are too often the triggering agents. The upset physiological patterns observed are often similar to those described for blue mold. The water-soaked appearance is usually the first sign noted. The structural and physical changes vary as to temperature, humidity, and the exact cause.

8-10. *Quality.* Some of the factors that influence the quality of fresh fruits and vegetables are appearance, texture, and flavor. These are in turn determined by the ripeness and maturity of the product as well as the surrounding atmosphere. The effect of each factor on the product is important to your inspection. An evaluation of these factors will assist you in determining the remaining storage life of fruits and vegetables as well as aid you in advising on the product's acceptability.

8-11. Criteria that figure into the determination of quality are the appearance factors—color, shape, and surface blemishes. These factors weigh heavily during the grading of fruits and vegetables. Remember, because most of the time the USDA will have already graded the items, you will not be greatly concerned about minor quality defects. If you should feel, however, that there are enough quality defects to cause you to question the grade of a lot or shipment, you can request that a formal review or grade reinspection be performed by the USDA. Remember that you are concerned with saving the Government money, and money would be wasted if US No. 2 potatoes were bought at US No. 1 prices.

8-12. *Grade.* The fruit and vegetable market has a definite need for uniformity in inspection procedures. Buyers and sellers, including Government purchasers, even though separated by thousands of miles, need to know precisely what each other is talking about. Identifiable grades permit buyers and sellers to understand each other. Grading and the initial inspection of fruits and vegetables have been a primary function of the US Department of Agriculture for many years. The USDA's guidelines or requirements for each individual product were not set up overnight, but have been in a continuing process of development—one that is still changing.

8-13. Its grading system for fresh produce is based on condition, quality, appearance, and other factors that affect edibility and waste. The grading standards were established with the cooperation of growers, marketers, and technicians throughout the industry who are specialists in each commodity considered. The grade rules, supplemented by State grading regulations, become the basis upon which trading is conducted in the industry.

8-14. Grades are generally designated by names, numbers, or a combination of both. US Fancy (or Extra Fancy) is the top grade reserved for those products of high color and of practically no defects. Since little of a crop is free enough of defects and injury to rate this grade, it demands premium prices. The basic trading grade is US No. 1, in general the highest grade of good average quality that is practicably packed under commercial conditions. This grade is the one most generally purchased by the military. Approximately 50 percent of the crop, under normal growing conditions, is of this grade. [illegible] No. 1 and US No. 2 is an intermediate grade for quality standards not high enough for No. 1 but above No. 2. This intermediate grade is US Combination (US Commercial) and is often used to describe the pack of a crop that is below average quality because of abnormal growing conditions. Consequently, US No. 2 grade ordinarily represents the quality of the lowest grade that is practicably packed under normal conditions. In addition, there are miscellaneous grades applying only to particular products: US No. 3, citrus; US Utility, apples; US Hail Grade, apples and pears; US No. 1 Bright, Bronze, or Russet—used for citrus; Combination US Fancy and US No. 1; US Extra Fancy, used for apples; US Extra No. 1 used for pears, peaches, potatoes, and celery. The one thing to remember about grading is that it is never, except in cases of specified local contracting, the responsibility of military veterinary specialists; but experience teaches you to be fairly accurate in recognizing grades as you inspect shipments of USDA graded products.

8-15. **Inspection Directives.** In order to perform a meaningful inspection of fresh fruits and vegetables you will need to have on hand and be familiar with certain directives used by Air Force food inspectors. We will briefly discuss the general content and use of several of these important publications.

8-16. *Specifications.* Specifications give a detailed description of the specific requirements for the product concerned. Often, though, specifications for fresh fruits and vegetables list some of the requirements, but refer the inspector to the applicable US Standard for a more detailed coverage of the specific requirements for that item. This leads us to the next category of publication we should discuss—the United States Standards for fresh fruits and vegetables.

8-17. *United States Standards.* These directives, published by the USDA, give much information that is needed for the proper examination of a product. The US Standards for asparagus, for example, list the possible grades for that item. They describe in great detail the requirements for each grade and give the tolerance allowed for undergrade items. Some very valuable information also found in US Standards is a list of definitions of many of the terms used to describe grading factors. For example, you are inspecting a shipment of US No. 1 grapefruit, which calls for fairly well colored fruit. What does this mean? This could be interpreted differently by different inspectors; however, the US Standards define "fairly well colored" in such a manner that everyone would interpret it the same way. Because of the useful and often necessary information found in US Standards, they should be readily available when you are performing an inspection of fresh fruits and vegetables.

8-18. *DPSC Articles and Clauses.* Articles and Clauses are published periodically to furnish additional information and terms for a contract. In these publications you will find supplementary information on such topics as inspection procedures, inspection certificates, or delivery requirements.

8-19. *Purchase Description.* We have looked at several publications that you will need to use to perform an inspection of fresh fruits and vegetables. Now let's look at another—the Purchase Description, which is usually found in the contract. It is used to describe qualifying factors that are unique or that are higher than those incorporated in the grade specifications. Sometimes the applicable US Standards is quoted to serve as the purchase description.

8-20. **Government Purchases.** Fresh fruits and vegetables are purchased either by DPSC or under a local purchase contract. Local purchases can be for single shipments, split shipments, or for an extended length of time such as a month, 6 months, or even a year. The term used for an extended time contract is "blanket purchase order." Under a blanket purchase order, prices may be adjusted each month to compensate for overall market increases or decreases. Your inspection responsibility on local purchases is generally confined to condition, identity, and net weight determination procedures. DPSC contracts are for large quantities to be shipped to several military installations and allow three different methods of purchase: street buying, field buying, and Subsistence Master Solicitation (SMS). The first two methods entail an actual visual inspection of the products, whereas SMS buying does not.

8-21. *Street and field buying.* Street and field buying are alike in that both use a visual selection procedure in which the buyer makes visual comparisons between competitive suppliers and his award goes to that product of the best value to the Government as to price, quality, condition, and other factors. In street buying, the procurement agent visits a terminal or local market, as contrasted with field buying where he visits growing areas or packing facilities to inspect and observe the products being harvested or packed. In both methods, the procurement agent contacts as many qualified suppliers as is practicable to assure full and free competition. In both methods, the buyers carry small looseleaf notebooks and record all offerings on DPSC Form 2176.

8-22. These are the criteria for purchase: (1) samples selected at random; (2) assurance that the supplier has sufficient quantity of product on hand to meet specific requirements; (3) complete buyer-seller understanding as to terms and conditions of contract, placing special emphasis on price, grade, condition, maturity, size, and other qualifying factors; (4) designation of an acceptance point where supplies are to be inspected for compliance and acceptance; (5) agreement that if all or part of the supplies delivered are not in accordance with award agreement, they are subject to rejection.

8-23. Precautions are also taken to assure that products delivered are those actually selected. These precautions include: (1) buyer annotates DPSC Form 2176 with brand, trade name, or other distinguishing marks; (2) buyer identifies a representative number of containers by stamping, with a rubber stamp, region, purchase date, and other dates; and (3) buyer follows through to greatest possible degree to insure that the products delivered are those actually selected and awarded.

8-24. *Subsistence Master Solicitation buying.* SMS buying is kept to a minimum, and in no instance is it considered proper to use SMS buying concurrently with street or field buying for the same item. Solicitations for procurement of fresh fruits and vegetables are made to interested qualified suppliers by the publication of an SMS if time permits, or in emergencies by telephone or telegraph message. The SMS lists items to be purchased, quantities, specifications, delivery dates, closing time, applicable clauses, and other essential information. Interested suppliers submit their offers by mail, TWX, verbally in person, or by telephone. All offers are recorded and subsequent award is based on the lowest price. The successful supplier must furnish a USDA certificate of inspection to substantiate contract compliance inspection.

8-25. Since we are looking at buying from the inspection angle, let's examine some malpractices connected with buying based on the lowest responsive price, particularly as it relates to local purchase of fresh fruits and vegetables for resale. Condition and abundance of produce are major factors in determining price. Items in good condition with maximum shelf life normally command a higher price. Deteriorated items are sold at prices in direct ratio to their degree of deterioration.

8-26. In order to preclude losing money (because of a low bid made in a rising market), contractors may endeavor to substitute lower quality merchandise, such as old produce that has been repacked. Contractors may resort to attempting deliveries at short weights which cannot be detected unless you are really alert and weigh 100 percent of the produce. For example, a vendor may take several hampers of green beans, dump them, fluff them up and water them just before delivery and get credit for an additional hamper.

8-27. **Contract Compliance.** Fresh fruits and vegetables for Government purchase are normally inspected for grade by the USDA. The USDA then issues an inspection certificate to indicate that the product complies with contract requirements for grade. The official inspection certificate (USDA or Federal-State Inspection Certificate, or official copy), when required, must be attached to the original invoice. The contractor annotates the number of the attached official inspection certificate on the invoice. Additionally, a copy of the inspection certificate accompanies each shipment from the lot.

8-28. In special procurements where the value of the produce does not justify the expense of USDA inspection, agents may inspect their own products, certify to contract compliance, and issue a Certificate of Conformance (COC). However, the contract must include an agreement that if the grade is questioned, the USDA will make an inspection. If the grade, as determined by the contractor, is upheld, the Government bears the cost of inspection; if the product is out of grade, the inspection is at the expense of the contractor.

8-29. When a shipment on which a COC has been issued is received, it is subject to inspection at destination for all terms of the contract. The results of such destination inspection are final unless the contractor specifically requests an inspection by the USDA. When a shipment is received without a required COC, the procurement agency is to request inspection by the USDA at the expense of the contractor.

8-30. **Air Force Procurement Inspections.** We have looked at some types of procurement inspections that are performed by DPSC Procurement agents; now let's look at some procurement inspections that you, as a veterinary specialist, may be called upon to perform.

8-31. *Class 3 inspections.* Class 3, or "prior purchase" inspections are used to determine compliance with contract requirements and wholesomeness. Generally, Class 3 inspections are performed by the USDA, but veterinary specialists perform them under the following conditions:

a. On request whenever produce is procured locally by an AF installation.

b. On request of a central procurement agency (DPSC or AF procurement).

c. In exceptional cases where the Surgeon General of the Air Force determines that the wholesomeness of food can be determined adequately only during its preparation.

8-32. *Class 4 inspections.* How is a class 4 inspection (DPSC Contract) at destination performed? The first step in class 4 inspection (DPSC Contract) for either a less-than-carlot (LCL) shipment or less-than-trucklot (LTL) shipment is to examine the USDA origin inspection certificate or to check the vendor's COC. A car or trucklot is 20,000 pounds unless stipulated otherwise.

8-33. The second step is to open the truck or car and see whether products match those on the inspection certificate. If they do not, or if no certificate is presented, halt the inspection and immediately contact the veterinary NCOIC or OIC. He should in turn notify the Quality Assurance Office, Subsistence Regional Headquarters of the Defense Personnel Supply Center (QAO-SRH-DPSC) and ask for further instructions. They will direct one of three actions: reject the load to the vendor, hold the load pending further investigation, or continue the inspection. In case the load conforms to the certificate, or if the QAO-SRH-DPSC has ordered the inspection continued, move to the next step.

8-34. In step three, select your sample. Determine the lot size from the vendor's invoice. Then select the sample size for condition inspection—use MIL-STD-105D, single or multiple normal S-3 level. Draw samples from both sides of the car, both ends of the car, each layer of the car, and around the door.

8-35. Step four is the actual examination for condition. Examine the representative sample for total damage, including rots, freezing injury, bruises, soft fruits, wilted or soft vegetables, the presence of live insects, or any defect listed in the specifications of US Standards. Compute your percentages of defects allowable (tolerances) at destination. If the defects are less than the maximum allowable, recommend acceptance; if the defects are more than the maximum allowable, recommend rejection or acceptance with a price adjustment. This recommendation is to QAO-SRH-DPSC, but don't contact them until step five has also been completed.

8-36. Step five is the examination of the product for net weight and, if more convenient for the inspector, can precede the listed step four (condition examination). Similarly, use MIL-STD-105D, but reference the single normal S-4 level, and select the sample size, this time for net weight examination. Refer to paragraph 3 of DPSC Clause 200a for an explanation of container weight requirements. If these requirements are met, along with the previously stated requirements, recommend the product for acceptance. If not met, advise QAO-SRH-DPSC and recommend rejection or acceptance with a price adjustment.

8-37. Class 4 inspections on locally purchased produce are performed in a manner similar to the examination on DPSC contact items. These inspections also are primarily confined to identity, condition, and net weight determination. Of course, the shipment must originate from an approved source. A major difference is that items going to the commissary will ultimately be accepted or rejected by the commissary officer (rather than by DPSC). Defects of the produce due to carrier damage (freeze damage or upturned crates) should be reported to the transportation officer if the shipment is accompanied by a Government Bill of Lading (GBL).

8-38. *Class 8 inspections.* Class 8 inspections, purchase by nonappropriated fund activities, are very similar to class four inspections. Reasons for recommending rejection are the same:

a. Contains off-condition or contamination.
b. Does not meet requirement of purchase documents.
c. Does not come from an approved source.

If you find a reason to recommend rejection of a class 8 product, you should notify personnel at the receiving activity. Inform the carrier of the reason why the product is not acceptable and annotate the invoice or the delivery tickets.

8-39. **Surveillance Inspections.** Surveillance inspections are performed on Government-owned produce. There are a variety of different types of inspections that fall into this category: Class 6, "Prior to Shipment;" Class 5, "Any receipt except purchase;" Class 9, "In Storage;" Class 7, "At Issue or Sale." Let's look briefly at each of these types of inspections. Since many of the procedures are the same for several of these inspections, we will stress only their major points.

8-40. *Class 6 inspections.* Class 6 inspections are performed on food items immediately prior to shipment. They are conducted at DPSC Supply Points and Depots before shipment to military installations, and they are also conducted at military installations that are shipping food items in support of sites or outposts. They are conducted to advise the accountable property officer (either the DPSC Supply Point or Depot Officer or Base Commissary Officer) as to compliance or noncompliance of the carrier with requirements for proper temperature, loading, etc., and as to the suitability of the product for its intended use.

8-41. DPSC requires that vehicles be precooled to at least 50°F. prior to loading. This insures that the refrigeration equipment is operating properly, and it removes the body heat from the vehicle. The trailer body must be completely tight when the doors are closed and the interior must be free of foreign odors which could transfer to the products after loading. Side walls and racks must be clean, and blankets or other equipment used as barriers must be clean and odorless. No freight other than food for human consumption may be included in the shipment. Loads may not be stacked closer than 10 inches to the ceiling so that proper air circulation will not be impaired.

8-42. Inspection of the product includes consideration of required temperatures, proper stock rotation from the warehouse, suitability for further storage at the destination, etc. Such inspections are conducted in accordance with the directives issued by the accountable agency.

8-43. *Class 5 inspections.* A class 5 inspection is performed on products that are already Government-owned; therefore, neither a COC nor a USDA inspection certificate should be anticipated. Examine the shipment similarly to a class 4 inspection unless DPSC regional headquarters specifies class 5 operating procedures, which differ. Remember that a class 4 inspection has been performed on the product before you received it. However, if the products are unduly damaged and do not meet the minimum tolerance for defects, your only recourse is to use DPSC Forms 2572-1 and -2 to report your findings to QAO-SRH-DPSC. The exception is in cases where the contract carrier has been at fault in causing defects. He can be held liable, and the distressed products are rejected to him. An example is a class 5 shipment of fruits and vegetables which arrives at your base in an extremely distressed condition due to poor refrigeration of the conveyance. Another example is where the contract carrier's conveyance was involved in an accident and a damaged portion of the load is rejected because the containers were broken open and the products bruised and mashed. In such instances, the transportation officer must be contacted.

8-44. *Class 9 inspections.* In Storage inspections are conducted to detect early signs of deterioration of products stored over 90 days. Fresh fruits and vegetables are generally not stored long enough to require a class 9 inspection; however, class 9 inspections can be used to detect faulty temperatures, warehouse facilities, or practices which may lead to deterioration of the products.

8-45. Occasionally, you may be stationed where fresh fruits and vegetables are stored for periods long enough to require a class 9 inspection. The procedures for an in-storage inspection of DPSC controlled stocks are outlined in the DPSC Subsistence Inspection Manual. Procedures for inspection of Air Force stocks in the accounts of commissary officers are governed by AFR 163-2 and by AFM 145-1, *Commissary and Subsistence Depot Operating Manual.*

8-46. *Class 7 inspections.* The purpose of class 7 inspections is to insure that no contaminated, decomposed, or otherwise unwholesome food is issued or offered for sale. It is performed at the time subsistence is issued from the warehouse to troop dining halls or to the commissary resale store. Class 7 inspections are performed on 100 percent of all foods at the time of issue or sale.

8-47. So far we have looked at the inspection criteria, the applicable directives, and the procedures for procurement, destination, and surveillance inspections of fresh fruits and vegetables. At this time we will discuss some of the individual products that you will undoubtedly be required to inspect.

8-48. **The Top Ten.** Merchandising and marketing organizations of fresh fruits and vegetables refer to various categories of produce in different ways—"The Tonnage Twins" (potatoes, bananas); "The Basic Five" (potatoes, bananas, apples, oranges, and lettuce); and "The Top Ten," which consist of the Basic Five plus tomatoes, grapes, grapefruit, onions, and celery. The top ten represent approximately 60 percent of the sales and 65 percent of the tonnage in today's retail produce departments. We will discuss each of the top ten items and the main methods of identifying the most popular varieties within each group. We will also discuss those condition factors that you should observe during your inspection of the product.

8-49. *Apples.* There are over 1,000 varieties of apples grown in the United States of which only about 20 are considered really valuable. Of these 20, 8 varieties dominate the market. These 8 leading varieties are: Red Delicious, McIntosh, Golden Delicious, Rome Beauty, Jonathan, Winesap, York Imperial, and Stayman. The size of apples is described in terms of the number of apples contained in a 40-pound box; 48 per box, for example, are extremely large apples, while 252s are the smallest that are commercially packed.

8-50. The US Standards for grades of apples specify the requirements of apples as to maturity, ripeness, shape, size, and allowable defects for injury, damage, serious damage, decay, and internal breakdown within each grade. Apples of desirable quality should be firm, have good flavor and color, and be free of decay and blemishes. The following definitions of a few apple defects will help you detect them.

a. Blue Mold Rot. The most common and destructive rot found in apples in transit or in storage. Its main characteristic is a soft, mushy, watery, tan to light brown decay.

b. Black Rot. A dark brown decay centering around worm holes or punctured areas. It grows much more slowly than blue mold rot.

c. Scald. Usually appears in the late stages of storage. It causes diffuse browning and killing of the skin.

d. Internal Breakdown. Usually denotes the end of an apple's storage life. Browning and breakdown of the tissue and mealiness are its main characteristics.

e. Freezing Injury. Tissues are water-soaked, rubbery, and bruised and the apples have a wrinkled, gray surface as a result of freezing injury. In severe freezing, a browning of the tissues is noticeable.

f. Overripeness. Tissues in an overripe apple are broken down; the flesh is mealy.

8-51. *Grapefruit.* On the average, a grapefruit is over three-quarters liquid. The weight is an indication of juice content, with the heavier ones being more desirable. Any two grapefruits of the same size often vary in taste and juiciness, but, as a general rule, the one that is heavy and firm, has a smooth texture, and is well-rounded, is better and juicier. The less desirable grapefruit is more coarse, puffy, and rough; these characteristics indicate a lack of juice as well as taste. The color of grapefruit ranges from pale yellow to russet or bronze.

8-52. There are two principal types of grapefruit: Duncan, containing numerous seeds; and Marsh Seedless, which has very few seeds. The pink-meated grapefruit is a cross-bred creation and some people consider it somewhat sweeter. Minor surface blemishes are not desirable but do not effect the eating quality. Severe bruises may indicate some internal breakdown. The condition factor definitions stated below will aid you during inspection of grapefruit.

a. Mechanical Injury. Growth cracks or broken skins that have not healed characterize this type of damage.

b. Skin Breakdown. Firm, sunken, dry, discolored areas appear in the skin. They are usually caused by excessively hot washing.

c. Blue or Green Mold Rot. Characterized by soft, brown, watery spots which are usually covered with either blue or green mold.

d. Stem End Rot. Causes brown, water-soaked tissues in the stem area. The rot gives off a sweet sickly odor.

e. Brown Rot. A brownish decay accompanied by a penetrating, rancid odor.

f. Internal Breakdown. In this condition, the rind has water-soaked areas.

8-53. *Oranges.* There are five popular varieties of oranges grown in the United States with Florida, California, and Arizona (in that order) making up our country's principal producers. Texas and Mexico are becoming increasingly important as producers of oranges. These are the five popular varieties.

a. Hamlin (Florida). This orange is a yellow, smooth-skinned, seedless variety, medium to small in size and oval-shaped.

b. Parson Brown (Florida). This type is of medium size and has an oblong shape. Its color is yellow or yellow-orange. It is smooth and thin skinned and has 10 to 19 seeds.

c. Pineapple (Florida). The size is medium to large. The skin is glassy and smooth. The color is deep orange with a reddish tinge. The seeds are large and numerous.

d. Naval (California and Arizona). A large, round, seedless type with a smooth, thick skin, and an orange to yellow-orange color.

e. Valencia (Florida and California). A large, slightly oval variety with a pale orange to yellow-orange color. It has smooth or slightly pebbled, thin, tough skin. The number of its seeds varies from 2 to 5.

8-54. The color of an orange is not a sure guide to quality. Many of the oranges produced in Florida and Texas have color added. This means that the fruit is dipped in, or sprayed with, a harmless vegetable dye solution at packing time which has absolutely no effect on the eating quality. Oranges treated this way must be stamped "Color Added" and must have passed very strict maturity tests. Don't be misled by a color change in late season. Valencia oranges turn from a bright orange hue to a greenish tinge, particularly around the stem end, which affects only the outer skin; the oranges actually are amply matured and the inside is fully ripe, sweet, and juicy.

8-55. As a general rule, quality oranges will be firm, will have a skin that is not too rough, and will be heavy for their size because weight is indicative of their juice content. Oranges, like grapefruit, are of the genus Citrus, and are subject to the same plant diseases and deteriorations. For a list of defects affecting oranges, use the same condition factor definitions as for grapefruit. There are three different US Standards and Federal specifications for oranges. One is for those from California and Arizona, another is for those from Florida, and the last is for those from Texas and States other than Florida, California, and Arizona.

8-56. *Grapes.* We will discuss four of the leading varieties of grapes. Thompson Seedless are white or green, small, olive-shaped grapes. They grow in very large bunches and are the most popular for household uses. The Flame Tokays are large, oval, red grapes. They grow in medium to large bunches. The Emperor is a large oval dark cherry-red grape and is much like the Tokay. The fourth type is the Concord which is extensively used for juice, jelly, and table use. They are large, round, blue grapes.

8-57. To be desirable, grape bunches should be of one variety. They should be mature, have a good flavor, and be firmly attached to the cap stems. When inspecting grapes look for:

a. Mechanical injury, such as grapes that are crushed or split.

b. Freezing injury which gives the grapes a dull, dead appearance; and grapes that are sticky, shriveled, or have a flat flavor.

c. Blue or green mold rot makes the grapes watery, mushy, or leaky; and the skin slips from them easily. In later stages, a growth of blue or green mold holds them together.

d. Overripeness or poor storage causes the grapes to become loosely attached to the stem. The grapes will become brown and brittle. You may note many grapes that are crushed, split, and wet.

8-58. *Bananas.* Bananas are shipped in the green state and are ripened domestically in a controlled atmosphere of ethylene gas. When you receive them, they may be in any one of three stages of ripeness:

a. Turning-ripe is a stage in which most of the peel is a pale-yellow banana color with the tip end green. The flesh is decidedly starchy, with poor, slightly tart flavor.

b. Firm-ripe is a stage in which the peel is a bright-yellow banana color with no more than a trace of green at the tips and no trace of brown specks. The flesh is firm and somewhat starchy with undeveloped flavor.

c. Full-ripe is a stage in which the peel is a typical yellow, ripe-banana color with flecks of light brown to dark brown. The flesh is mellow with practically all starch converted to sugar, and the flavor is fully developed.

8-59. Often, banana contracts specify that the bananas are to be hands having not more than X percent clusters by count and not more than X percent loose fingers by count, using random samples of 10 percent of the pounds in the shipment. There are a few terms used in contracts for bananas that you need to know to perform your inspection.

- A banana is called a finger.
- Three to seven fingers attached to one another but removed from the stem are called a cluster.
- A hand consists of eight or more fingers in a cluster.
- A banana bunch consists of not less than eight hands attached on a stem and weighing not less than 50 pounds.

8-60. In performing a procurement inspection on bananas, observable defects are split peel, scars or other discoloration, bruises, cuts, punctures, decay, improper ripening, and incorrect stage of ripeness. Additionally, bananas that are overripe or soft will have badly discolored skin and very soft flesh. Chilling injury is identified by a dull colored skin which is sometimes brown. Anthracnose, a fungus disease, appears as a brown discoloration, which slowly turns black, and which may be accompanied by white mold. Tolerances for defects are listed in either the procurement document or applicable specification.

8-61. *Tomatoes.* The different varieties of tomatoes available include the red, the hot house, and the cherry. The red tomato is most abundant; however, the hot house is most desirable because of its superior taste quality. The cherry tomato is a small tomato, popular for use in salads or for snacks. Tomatoes that are to be shipped any distance are picked when mature but before they are ripe; that is, before they attain red color. They will ripen during shipment or can be ripened by wholesalers in specially built rooms and then graded for color defects and size. A mature green tomato has a glossy green surface with a whitish overcast. Its seeds are well developed. A pink tomato has a slight trace of pink or red at the blossom end. A tomato that is fully ripened is completely red or pink.

8-62. A tomato of desirable quality is mature, well formed, plump, firm, and free from blemishes. Defective tomatoes are a poor buy even though they may cost less. The savings are nullified by the waste. Insure that the tomatoes you accept do not have defects that exceed the allowable tolerances. Here are a few observable defects you should be familiar with:

a. Overripeness or softness. Becomes a defect when more than 5 percent of the fruit is overripe or soft.

b. Puffiness. Characterized by a spongy textured flesh which is light in weight and has large air pockets in the flesh.

c. Drying, mechanical, or virus injury. These conditions make tomatoes appear discolored, mottled, dirty, blotched, or streaked, bruised, shriveled, or wrinkled.

d. Worm damage.

e. Shoulder scar. Sunken, dark patches on a tomato's shoulder.

8-63. *Celery.* There are two distinct types of celery: Golden Heart, which is bleached white; and Pascal, which is green in color. Pascal is favored because of its distinctive flavor and almost complete lack of stringiness, but either type is acceptable. Celery of good quality has leaf stems or stalks that are brittle enough to snap easily and that are of medium length and thickness. The inside of the stem is smooth. If it feels rough or puffy (spongy) to your finger, the celery is likely to be pithy, a condition that is not desirable.

8-64. Of the defects found in celery, the following are the most common and can be identified by the conditions listed:

a. Blight is characterized by wilted tops having circular pale yellow spots which turn brown to ashen-gray in advanced stages.

b. Blackheart appears as a brown and black discoloration of the heart leaves and is reason for rejection.

c. Bacterial soft rot produces a water-soaked soft tissue, which turns brown and becomes mushy. No offensive odor or sliminess accompanies this condition.

d. Watery soft rot is characterized by light brown decayed areas with pinkish borders. There is considerable leakage from the affected tissue.

e. Freezing injury makes the stalks limp and dry.

8-65. *Lettuce.* The four popular types of lettuce are iceberg, Boston, romaine, and leaf. Iceberg, the most popular of all, is round and tightly headed with very crisp leaves. It is medium green on the outside and has a pale green heart. Boston has a rounder, softer, and lighter head than the Iceberg. It is medium in size, with light green outer leaves and pale yellow inner leaves. Romaine has an elongated, stiff head. It is moderately firm with a coarser leaf and a stronger flavor than the iceberg. Leaf lettuce is not a head but, as the name implies, is like leaves. It has either a curled or smooth leaf with a crisp texture.

8-66. Head lettuce of desirable quality is tender, well trimmed, and firm. It should not have an excessive amount of outer leaves. Quality leaf lettuce is crisp, loosely branched from the stalk, and well trimmed. Lettuce of desirable quality is free of any of the following defects:

a. Drying or overmaturity. The outer leaves become severely discolored.

b. Tip burn. Dead brown areas along the edges of the inner leaves.

c. Bacterial soft rot. A soft, mushy consistency of the decayed tissues. It commonly follows tip burn or wilting.

d. Water soft rot. A wet, leaky, pinkish-brown decay.

8-67. *Onions, dry.* The two most popular varieties are domestic and Bermuda. The domestic onion has a globular shape. It is of medium size, and may be red, yellow, or white. The Bermuda onion is flat and may be either yellow or white. It has a milder flavor than the domestic. Quality onions of both varieties are bright, clean, hard, and well shaped. Their skins are dry and will rustle in the sack.

8-68. It is difficult to detect onions with internal rot unless you feel them for softness. Besides internal rots, there are many defects that occur in onions. Listed below are a few of the more common defects observed during deliveries:

a. Poor storage and handling. The onions become soft and flabby. The sprouts are more than three-quarters of an inch long in some cases. They are soggy at the neck and are not completely free of doubles, splits, or roots on top.

b. Ammonia injury. Causes surface browning on yellow onions, deep metallic black on red onions, and greenish yellow on white onions.

c. Freezing injury. Slight freezing damage gives a water-soaked, grayish-yellow appearance to entire fleshy scales. Severe injury affects all scales and makes them flabby. Scales that are affected have opaque areas.

d. Bacterial soft rot. Appears as a very mushy decay which affects the scales inside the bulb.

e. Black mold rot. Characterized by black, powdery spore masses on or between the scales.

f. Fusarium rot. A semiwatery to dry decay, progressing up the scales from the base, usually covered with a white to pinkish mold.

8-69. *Potatoes, white or Irish.* There are many varieties of potatoes but industry generally classifies them into five basic types: the Round White, Russet Burbank, Russet Rural or Round Russet, Round Red group, and the Long White group. Some are best for boiling and baking; others for cooking, french fries, potato chips, or dehydration for instant potatoes. Most potatoes are harvested from September to November and require storage to allow year-round availability. The two leading potato producing states are Maine and Idaho. New or early potatoes have a thin, feathery skin and high moisture content at the time of harvest. Old or storage potatoes have a thicker skin and are more fully mature. Potatoes that are stored have a chemical sprout inhibitor applied as a dust or in the wash water. Potatoes are best stored in a cool, dry, dark area. If stored in light, the surface of the skin will green, due to chlorophyll development. This greening often occurs as a result of overhead lights in the display area at the retail store or commissary.

8-70. Potatoes of desirable quality are firm, relatively smooth, clean, and reasonably well shaped. They are not badly cut, bruised, wilted, sprouted, sunburned, or lightburned. The size does not affect quality and is a matter of choice for the particular use. The following are defects you may detect during inspection of potatoes:

a. Improper storage. Flabby sprouts over three-fourths of an inch long.

b. Scald. Slightly shrunken or discolored areas, some of which are sticky.

c. Mechanical injury. Bruises, air cracks, and cuts are responsible for more than 5 percent of a potato being wasted.

d. Greening. Green coloration in layers of flesh next to the skin characterize this condition.

e. Watery soft rot. Wet breakdown and smearing and wetting of potaotes, sacks, and floors.

f. Freezing injury. Causes browning of the vascular system of the flesh of the potato.

g. Black heart. A dark gray to jet-black area in the center of the potato. No external symptoms are visible as a rule.

h. Bacterial ring rot (dry). A yellow, soft, cheesy decay of a thin layer of tissue in the vascular ring.

i. Slimy soft rot (bacterial soft rot). The most common and destructive rot that affects white potatoes.

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Waterfoods

AS A VETERINARY Specialist, you may be called upon to perform inspections of fish or shellfish (referred to as waterfoods in this chapter). You may have to inspect a product in a processing plant from the time of off-loading until the final packaging of the item. Most likely, you will perform destination inspections of waterfoods at base level. Whatever the case, you need a sound knowledge of processing procedures, of classifications of waterfoods processed for purchase by the Armed Forces, and of the correct steps in the inspection of these products.

2. In this chapter we will discuss many aspects of processing and inspecting waterfoods. Our discussion of processing will include the classifications of fish procured for use by the Armed Forces and the procedures involved in processing and packaging seafoods. In our discussion of seafoods inspections, we will also consider the means of identifying many of the types of fish and shellfish. We will see how to determine the condition of these waterfoods from the time of harvest through processing, packaging, and storage. Finally, we will look at some procedures used to inspect these food items during processing upon receipt at destination and during storage on base.

3. Since you will be required to inspect chilled, frozen, and canned products, you must be able to recognize the acceptable and unacceptable quality and condition factors for the seafoods procured for military use. You must learn the changes which waterfoods undergo from the time they are caught until they are consumed. Because waterfoods deteriorate rapidly, you must know the various methods of retarding this deterioration and preserving their quality, flavor, palatability, and desirability.

4. As a military inspector, you should know the nature and extent of the role that other federal agencies play in the inspection of military-procured waterfoods. For example, waterfoods procured by the Armed Forces must be from establishments listed in either the "Directory" or in "Guides to Federally Inspected Fishery Products." Establishments that process fresh and frozen oysters, clams, and mussels must also appear on the U.S. Public Health Service's "Interstate Shellfish Shippers List."

5. Finally, you will need to understand principles of inspection of both the procurement and distribution of all fish and shellfish consumed by Air Force personnel. The objective of this chapter is to provide you with the knowledge to complete the task before you successfully.

9. Fresh and Frozen Fish

9-1. When performing inspections of fresh and frozen fish, you must be able to identify the product and insure that it is the item intended for purchase. To aid you in identification, this chapter includes the military classification of fish. After you have confirmed the identity, check the condition. You must determine whether parasites are in the product and, if so, whether they are a health hazard. This section contains information that will help you make these determinations. Also included in a description of fish processing and an outline of the proper inspection procedures.

9-2. **Identification.** When you try to identify any species of fish purchased by the Armed Forces, always use constant (unchanging) characteristics. Characteristics that are not altered by handling or storage of the fish are generally a reliable means of identifying species because they are not subject to much variation. When you use fins as a means of identification, observe them for structure, number, type (spiny or soft), and position on the body. You may also use the position of the lateral line and of spines on the head.

9-3. When you determine the identity of a fish, rely upon color only as a last resort. Color patterns in fish are variable and depend much upon how a fish was handled after it was caught. Colors such as red, yellow, and blue tend to fade rapidly once a fish is dead; therefore, they are practically useless as a means of identification. On the other hand, black and brown pigmentation does not fade rapidly and generally can be used with a fair degree of confidence.

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TABLE 1
CHARACTERISTICS OF FISH

	FRESH FISH	STALE FISH	PUTRID FISH
Appearance	Bright (Fish has lost none of its freshness or bloom)	Dull and dry	Loss of all brightness and luster; color is dull and lifeless, decomposition apparent
Odor	Void of odor, or odor is characteristic of its species	Offensive	Very offensive
Mouth	Closed, unless fish suffocated; then mouth may be open	Open	
Eyes	Prominent and clear	Opaque, dull, sunken	Greatly sunken
Gills	Bright, red, no evidence of off-odor	Pale yellow, dirty or grayish red, covered with slime of a disagreeable odor	Gray or brown, offensive odor
Scales	Shiny and adherent	Dull and easily removed	Loose, covered with a smeary slime which has a very offensive odor
Surface Slime	Clear and odorless	Body surface may be slightly slimy or smeary or abnormally dry	Dark, viscous, offensive odor
Flesh (Meat)	Firm and elastic	Soft and is easily removed from the bone	Withered and flabby
Finger Impressions	Will not remain	Easily made and will remain	
Abdomen (round)	Normal, firm, and elastic abdominal walls; no evidence of bloating or discoloration	Walls soft and flabby (abdomen may be starting to bloat)	Walls soft, pulpy, and discolored; abdomen of round fish is bloated and may even burst
Vent (anus)	Flat or normal	May be slightly protruding	Protruding
Blood	Bright red, no odor	Dull-colored in abdomen, usually with a slight off-odor	Dirty-brown with an offensive odor
Held in hand	Rigor holds it firm	Body feels bony and bends easily (especially at the tail end)	Drapes over hand loosely
In water	Sinks	Should sink but may float	Floats (gas in poke)

9-4. Confirm the identity of a lot by checking the characteristics of the fish presented against the characteristics described for the specified species. If deviations appear, the fish presented may be of an unacceptable species, and should tentatively be rejected until positive identification can be made.

9-5. **Condition.** Deterioration sets in immediately after fish are caught, and the delicate aroma and flavor of freshly caught fish are replaced in a few hours by a stronger, less agreeable odor and flavor. This deterioration continues until the product is no longer acceptable as food. Fish deteriorate in a progressive manner, going through three stages: rigor mortis, autolysis, and finally spoilage or putrefaction.

9-6. *Rigor mortis.* Rigor mortis is the apparent stiffening effect caused by the contraction of the skeletal muscles of dead animals. When normal metabolism ceases, certain acids accumulate in the muscles and cause them to contract. The presence of these acids then keeps the muscles in a contracted state. Rigor can be identified in fish by applying finger pressure to the surface, forming a dent. When the pressure is removed, the depressed spot will regain its original shape. Authorities attribute this stiffening to biochemical reactions within the muscle. While the theories on rigor mortis make interesting study, your concern is the practical use of rigor mortis in the fish industry; for example: Is rigor mortis good? Bad? How long does it last? What do handling procedures have to do with its occurrence? Let's examine rigor mortis in the light of our interest.

9-7. Is rigor good or bad? For the fish industry, rigor is a very desirable state. The acidification of muscle that occurs during rigor exerts a beneficial bactericidal effect. Hence, spoilage from bacterial action is reduced and held in abeyance. Thus, from this standpoint, rigor aids in maintaining storage quality. If of sufficient duration, the fish can be processed during the rigor stage and will withstand longer storage. A prolongation of rigor mortis, consequently, is of great economic importance.

9-8. How long does rigor last? Rigor mortis lasts longer when the fish has exerted little muscular activity prior to death and is refrigerated immediately after being caught. Handling before and during rigor mortis should be minimal. Rigor can be prolonged by maintaining fish at or near 32°F. for up to 120 hours.

9-9. How do handling methods affect rigor? When fish are netted, they panic and struggle for a relatively long period of time. Fish caught in such a manner enter rigor very soon after death, depart from the condition rather quickly, and have a relatively short storage life. If the fish are landed with a minimum of struggling or are killed immediately after boating so that predeath activity is minimal in duration and violence, they have a longer term of rigor and keep better.

9-10. *Autolysis.* Autolysis is a spontaneous disintegration of cells by the action of their own enzymes; it begins immediately after death. If the fish in question are eviscerated and beheaded, the degree of enzyme-caused spoilage is reduced. If they are left in the round (not dressed) as are ocean perch, the possibility of spoilage is very real. Chemical methods of testing for autolysis are complex and have not proven to be reliable. Therefore we are forced to fall back on the organoleptic or sensory means for evaluating the degree of spoilage. Thus, when inspecting the more susceptible species, check for autolysis in much the same manner as for bacterial spoilage—smell them.

9-11. *Putrefaction.* This is a state or stage of relative lack of freshness. For a better understanding of freshness, it is best that we consider all stages: fresh, stale, and putrid. Table 1 gives you this comparison of observable characteristics. What we want is the best quality of fish available. We accept fish for processing in either rigor or early autolysis. We will not accept fish that are in advanced autolysis or that are putrid.

9-12. *Oxidation changes and rancidity.* Oxidative changes primarily affect the fat content of the fish flesh. Oxidation causes a lowering of quality. At the time of death, fat-splitting enzymes are released and may free or break down the fat. Unsaturated fish fat will oxidize even though frozen, and you must inspect for such an occurrence. Perhaps the first indication of oxidation is rancidity. Rancidity results in a bitter flavor which leaves a tallowy, soapy taste and a strong and pungent odor. The color of the fat changes from the normal clear to yellow and then to brown.

9-13. *Parasites.* The last condition of fresh fish we are going to discuss is parasitism. Several types of parasites, both internal and external, affect various species of fish. The internal types include parasitic worms, their larvae, and cysts. They are located in the intestinal tract and just under the skin in the abdominal cavity and are usually removed during the cleaning process. From our point of view, those which infest the ocean perch are most important because we buy fillets produced from these fish. The perch parasite, a small crustacean called the copepod, burrows into the flesh and lives off the tissue juices of its host. Being a crustacean, just as are shrimp and crabs, it may very well be edible. However, most of us have an aversion to eating foods that we feel are contaminated, so such parasitized fish are rejected as a matter of course.

9-14. In the commercial trade, perch are often sold without candling. For our purchases, though, we require routine candling of these fish, because we know they are subject to parasitism. We are permitted to accept fillets of Pacific Ocean perch with a tolerance of no more than two parasites per fillet. If more are present, the fish must be rejected. If the vendor can remove the excess parasites without mutilating the fillet, we can accept them when they are resubmitted.

9-15. **Processing.** Fish procured for the Armed Forces are primarily frozen fillets, steaks, or portions, rather than fresh whole or dressed. As a Class 3 inspector, you will inspect the fresh product and will be concerned with sanitation and specification requirements. First, we will discuss the classifications established by specifications and then briefly cover filleting, steaking, portions, and freezing and storage.

9-16. *Military classifications.* Fish are procured for military use under Federal Specification PP-F-381. This document will be your guide to the acceptable quality level and the form of procurement. It classifies the fish into two basic types of preservation. The first of these is Type I—Chilled, which categorizes those fish marketed in a chilled state and which have not been previously frozen. The second class is Type II—Frozen. This title tells you that the fish will be solidly frozen when you see it. Beyond that, you should know that some fish are frozen following boating, are then thawed for processing in the cannery, and are refrozen for supply to the markets.

9-17. The cited specification also lists six forms in which fish are supplied to the user.

(1) Form I—Whole or Round (not dressed). When a fish is supplied to the market without being cleaned (gutted) or beheaded, the trade refers to them as "in the round." This expression means that the viscera, head, fins, and tail are intact. The buyer must do his own processing.

(2) Form II—Dressed. This form varies in accordance with the type of fish and how it is prepared for market. It may not be the same degree of processing in all cases, because some fish do not require descaling or skinning.

(3) Form III—Fillets (single or butterfly). This is the market form for some of the smaller fish. The edible, meaty part of the fish is sliced free from the bony structure and is further processed in this form.

(4) Form IV—Steaks. This is the manner of dividing into marketable portions large, meaty fish, such as salmon, cod, etc.

(5) Form V—Chunks. This is a term you will see used with tuna, for example. It means that the edible portions are broken or otherwise divided into small, irregularly shaped pieces.

(6) Form VI—Portions. This is the specification title for such popular forms of fish as "fish sticks" or "fingers."

9-18. *Filleting.* A fillet is a side of flesh, cut away from either side of the fish along the backbone from behind the pectoral fin back to the tail section. If the part of the flesh that forms the wall of the visceral cavity remains with the fillet, the fillet is called a fullnape fillet. Most high-quality fillets do not contain the nape. Fillets are generally marketed in three ways:

(1) Skin on—the skin of the boneless fish flesh is left on, as in ocean perch or whiting.

(2) Skinless—the skin is removed, as in cod, pollock, and certain flat-fishes.

(3) Butterfly—two fillets are left fastened together by the uncut skin of the belly, as in whiting.

9-19. Filleting may be done by hand or by machine. Ragged fillets, fillets with bruises, fins, bones, pieces of skin (if skinless), and other areas, are trimmed. After the fillets are trimmed, they are washed in cold brine or cold potable water and cleaned and drained before they are packaged. Brine is used to minimize drip formation when the frozen fish thaws, and to give the fish a better flavor. Salt, however, may accelerate rancidity and discoloration in storage, particularly if the salt contains magnesium or calcium.

9-20. After being washed, the fillets are packaged in moistureproof wrappers. The specification or purchase instrument gives detailed requirements about the packaging and packing materials. Fillets may be wrapped in units of about 1 pound. These units are then usually packaged in 5- or 10-pound waxed cardboard cartons.

9-21. *Steaking frozen fish.* The steaks most commonly bought by the Armed Forces are those of halibut, king, and silver salmon. Immediately after the fish are removed from frozen storage, the dorsal and vertical fins are shaved away with a large sharp knife. The fish are than hauled to a bandsaw where the steaking operation begins. Two or 3 inches of the gristle of the nape are removed with the first cut.

9-22. With the second cut, the belly and nape are removed as one unit. This unit is separated into two pieces with the third cut. Large steaks from the loin are divided into smaller pieces for sale, and cooking cuts may be diced into two, three, five, or six smaller steaks. The steaks get smaller in diameter as the tail is approached.

9-23. Salmon and halibut are handled similarly, except that two saws are often used for salmon. When steaking salmon, the first sawyer trims away the fins, saws off the head behind the gills, and removes the collar or nape containing the tips. (These tips are often saved and smoked for sale as kippered salmon tips.) The second sawyer cuts the steaks right down to the tailpiece. Tail steaks that are too small for a single small serving may be used for animal food, or they may be sold commercially as tail fillets.

9-24. Fish steaks are packaged commercially in waxed cartons, which are made from flat cut blanks and are shaped by hand, by manually operated machines, or by automatic machines. For Armed Forces purchases, the glazed steaks are usually packed unwrapped in waxed paper-lined shipping containers. The steaks are arranged in layers, one steak in thickness. Each layer is separated by waxed paper or unwaxed vegetable parchment. The top layer is covered by a sheet of waxed paper in addition to the container lining. The steaks may also be individually wrapped.

9-25. *Fish portions.* Portions are a product developed especially for the Armed Forces. Two important advantages of this product are uniformity in size and reduction of waste. The portions are made from pan-frozen blocks of skinless fish fillet. The blocks are sawed on a bandsaw into portions of serving size (3" x 3³/₄"), or into portioned blocks, each consisting of three portions.

9-26. *Preparation for canning.* Canned fish may be prepared from either fresh or frozen fish. The fish (thawed, if frozen fish are used) are conveyed to the butchering table where the belly wall is slit from the head to the vent, and the viscera removed. A state cannery inspector may grade the fish for condition by the odor of the belly cavity. The cannery inspector culls stale or tainted fish.

9-27. Specifications usually state that fish for canning must be precooked until excess moisture has been removed and the flesh can be easily separated from the bones. The fish are placed in steam chests where they are precooked in preparation for filling into cans. After precooking, they are cooled until the flesh is firm enough to handle.

9-28. Next, the cooled fish are dressed. The heads are removed and the fish are fed into the machine, tail end first, back down. The tails are removed, the bellies are opened, the viscera are removed, and the inner walls of the abdomen are scrubbed with revolving brushes. The dressed, cleaned fish are conveyed on belts to elevated storage hoppers. Fish discharged from the hoppers pass onto an apron connected to the filling machine. The automatic filler cuts the fish into proper lengths and fills a specific amount of fish and salt into each can.

9-29. After the can is filled with meat, it passes under an automatic oil dispenser which ejects a measured amount of hot oil into the can. The oil serves two purposes: it replaces the strong, fish-flavored natural oil which was purposely removed in the precook, and it keeps the fish from being scorched during further processing.

9-30. In addition to purchasing fish that are fresh, frozen, and canned, the Armed Forces buy cured fish. Among the different methods of curing fish are salting, pickling, and smoking.

9-31. **Inspection.** The best inspection is one in which you can observe all steps of processing. It is especially advantageous if you can examine the fish in the round (whether it is to be processed further or not) and perform an organoleptic examination.

9-32. *During processing*. Freshly dressed fish must be free of bruises and blemishes and in prime condition. Although parts of the fish that might be indicative of quality (eyes and gills, for example) are removed in the dressing process, the inspector still has several other points to assist him. Blood in the kidneys must be odorless and bright red; the inside of the nape and the belly walls must be clear and bright; the flesh must be firmly attached to the rib bones; and the scales, slime, odor, and appearance must be typical of fresh fish.

9-33. When the purchase instrument calls for veterinary inspection before and/or during processing and packaging, you will have the opportunity to inspect the fish in the round. If you are satisfied with the whole fish, then follow the fish through processing. Maintain the identity of the fish during all processing to insure that no substitutions of the product are made. Check the fillet washing and brining operations to insure that the brine is not too strong, and that the fish are properly washed.

9-34. If the fillets are to be "skin on," the fish must be scaled and washed before thay are cut. If skinless fillets are purchased, you should see that no pieces of skin are left on them.

9-35. Soft, gelatinous fillets should be rejected. These fillets can usually be distinguished from normal fillets beause they have a more translucent appearance. Six other aspects to check are:

(1) Processing time. Determine that time is within prescribed limits, and that the product is not unduly exposed to deterioration before it is packed in ice and/or placed in the freezer.

(2) Candling. See that such fish as ocean perch and "inshore-caught" Atlantic flounder, cod, and haddock, which are likely to be parasitized, are candled properly. No more than 2 parasites per 100 fillets are allowed except for Pacific Ocean perch, which may have 2 parasites per fillet.

(3) Trimming. Be sure that the product is properly trimmed.

(4) Packaging and packing. Insure that packaging and packing conform with contract requirements, applicable markings are correct, and net weights are correctly taken.

(5) Scales. Check weighing scales for accuracy and allow for freezer shrinkage if the product is to be frozen.

(6) Recording lot numbers. Record lot numbers or other means of identification so that the identity of the product can be maintained until time to ship it.

9-36. The inspection of frozen steaks starts with the frozen fish. Determine the condition and quality by inspecting the frozen fish before, during, and after the steaking operation. Acceptance or rejection is based on the appearance and odor of the frozen product.

9-37. Determine if steaks meet thickness requirements and if variations in thickness are within acceptable specification limits. If individual cross slices are divided into two or more pieces, they must be cut on horizontal and vertical lines. Be alert to detect increased thickness of steaks cut from the caudal peduncle so that they meet minimum weight requirements. Determine the tare weight of the glaze on the steaks.

9-38. Six months is the maximum safe storage period for most frozen fish. This time is calculated from the date the fish was initially frozen, with these exceptions:

a. Fillets of Pacific Ocean perch and bocaccio—120 days.
b. Chilipepper, lobe-jawed rockfish, red rockfish, orange rockfish, and channel rockfish—60 days.
c. Atlantic Ocean perch—120 days.
d. Halibut steaks—270 days.

9-39. The Federal specification for chilled and frozen fish gives the maximum storage limits at the time of acceptance for the various species. All fish must be in prime condition regardless of how long they have been or are to be stored. Because of improper storage conditions, some fillets may become stale and rancid after 4 months' storage; they should be rejected in spite of contract clauses that allow fillets of up to 6 months' freezer age.

9-40. *Inspection of canned fish*. The state inspector draws a representative sample of each code packed. Get the results from him and a copy of the certificate that releases the codes for shipment. When fish are given an in-process inspection, the cutout examination is performed soon after the product is packed. Use a predetermined inspection plan and change the plan for each code. This method insures a representative sample of each code.

9-41. Hold the samples until their contents are near room temperature. This allows the oil to rise, causes normal or abnormal odors to be readily detected, and assists in determining the vacuum. Using a vacuum gauge, determine the inches of vacuum for each of the remaining sample cans. Enter defects on the inspection record.

9-42. Invert the filled open cans on a tray adapted for quick drainage. The tray should hold 10 or more sample cans adequately and should fit snugly into a fluid-collecting pan. As the cans are lifted, sniff them for objectionable odors and observe them for interior defects. Examine the solid contents for flavor, odor, and taste. Break the product with both hands and quickly hold your hands close to your nose for detection of off-odors.

9-43. Note the condition of the skin and observe the flesh for honeycombing, watermarking, or pew marks which detract from the overall appearance. Look for pieces of gill, fin, viscera, detached skin, blood clots, hard rigid bone, pieces smaller than one-fourth of the volume capacity of the container, dirt, insects or insect parts, glass, wood, hair, metal particles, and other extraneous material.

9-44. After the visual inspection, smell and taste the fish. Texture is examined by feeling and eating a small sample of flesh. Any off-odor or objectionable taste must be noted on the inspection record. Sour or putrid flesh is recognized by its unpleasant odor. If the cans received insufficient oil after filling and were cooled slowly, the flavor of the flesh may be scorched or burnt.

9-45. *Inspection of cured fish.* The fish must be properly split and cleaned. No parts of viscera may be present (unless cured round), and blood must be washed off. The flesh should not be excessively cut or scored as a result of poor workmanship. Salt and pickle must be of first quality and must not impart off-flavors to the product. Wood used for smoking must not give the fish undesirable flavors or odors.

9-46. The flesh must be completely cured throughout. The easiest way to see if it is thoroughly cured is to cut into the thickest part. There must be no evidence of rancidity, bacterial spoilage, or other off-conditions. Cured fish should always be stored in a dry, cool place.

9-47. *Preaward inspection.* Because of seasonal variations and unpredictable catches of various seafoods, preaward inspections are done so that seafoods can be stockpiled to the prospective vendor's account during the flush season, for probable purchase by the Armed Forces during off-seasons. This system of inspection is highly advantageous to the Government because products are inspected before and during processing instead of only after processing. Also, the Government assumes no obligation to buy the inspected stock in storage; moreover, storage charges are assumed by the prospective contractor and not by the Government.

9-48. Preaward inspections also benefit the contractor because he has in storage a high-quality product that meets Government specifications and that he can apply to Armed Forces contracts during the off-season. Further, the contractor is not obligated to sell the product to the Government, but may channel it through any outlet he chooses.

9-49. Inspect the product just as if it were being bought at that time. Identify the containers with the DOD Partial Inspection Approval Stamp, coded with the letter "03" indicating "Preaward Inspection." The product is test weighed at destination, after actual purchase and delivery to a Government installation. The tare weight, including the weight of the glaze, is determined at origin.

10. Shellfish

10-1. Our discussion in this section covers shellfish, which include mollusks and crustaceans. Shellfish are any aquatic animals with a shell, but we will discuss only those that are edible and which are frequently purchased by the Armed Forces.

10-2. Before we discuss mollusks, you should know that humans may be poisoned by eating shellfish. This poisoning is called paralytic shellfish poisoning. Shellfish may contain poison, which is taken from certain waters. The shellfish that contain this poison are principally clams and mussels, and are usually found on the Pacific Coast from Alaska to southern California, and on the Atlantic Coast in the Maritime Provinces of Canada. Oysters are rarely poisonous. Scallops may be toxic, but because only the scallop muscle is eaten, they have less public health significance than clams.

10-3. The shellfish obtain the poison by feeding on small planktonic marine organisms *(Gonyaulax catenella),* which may be ingested without harming the shellfish. This plankton, most plentiful in the summer, can become so numerous that it colors the water red. This condition is sometimes called "red tide." The toxin of the ingested planktonic organisms accumulates in the digestive glands and other internal organs of the shellfish where it may reach high concentrations. A person who eats such shellfish may be severely poisoned, and his extremities may become paralyzed.

10-4. **Mollusks.** The mollusks with which we are most concerned are scallops, clams, and oysters. All are relatively simple life forms, and their specific anatomy is not too involved. All three are classed as bivalves because their covering shell is in two parts hinged on one side. They spend their lives on the sea floor. Oysters root to one spot where they stay; clams, likewise, are found in beds where they live embedded in the sand and mud; scallops are the exception in that can move about or remain in one spot as the food supply warrants. Scallops are harvested from beds, however, in much the same manner.

10-5. *Scallops.* Scallops differ from oysters and clams in that they retain their mobility throughout their life (except for the rock scallop, which attaches itself to a rock where it remains throughout its life span). Scallops don't swim in the manner of fish, but rather are jet-propelled. By rapidly opening and closing their valves, scallops force water from within the shells, causing them to recoil in the opposite direction. In this way, they can move with or to the food supply. Because of their mobility, they are found in deeper water than are clams and oysters, and are less likely to be contaminated by the pollution found in streams.

10-6. While the entire meaty part of scallops is edible, the usual procedure is to discard all but the central adductor muscle. Some eat these muscles raw and acclaim them delicious, while others prefer them cooked. Scallops cannot—or rather do not—retain entrapped water; therefore, they die soon after netting. They must be processed immediately after being boated. Scallop fisherman shuck the scallops, clip off the adductor muscle, and discard the balance of the creatures. The muscles are then placed in cold storage in muslin bags to await delivery to the cannery.

10-7. Scallops are already shucked when they are delivered to the cannery and need only to be cleaned and packed. Those intended for inland markets are commonly canned and frozen. Some of the crop is marketed in the breaded form, either raw or precooked.

10-8. Prior to processing, you must insure that the scallops are in prime condition. Spoilage or staleness is usually noted when a characteristic gassy odor escapes from a bag of scallops. After the scallops are washed and drained, inspect for pieces of shell and adhering grit, which are causes for rejection.

10-9. The best quality scallops are white or creamy in color, although yellow, orange, pink, or light gray colors do occur. There are acceptable limits for colors other than white. Improper chilling or holding too long before freezing causes scallops to become dark gray or black. These are not acceptable. A yellowish tinge in frozen scallops indicates rancidity or oxidation. When you suspect this condition, confirm it by defrosting and checking the odor, or by cooking and tasting.

10-10. *Clams.* In our discussion of clams, we won't worry about all the varieties marketed commercially. Rather, we will concentrate on the type used in canned chowders because this form is more suitable for our use.

10-11. Soft-shell clams are the species harvested in greatest abundance in the New England States. This clam lives on tidal beaches for the most part; diggers gather them with hoes, rakes, or tongs. After being caught, the clams are often stored in live boxes or floats because when they are kept in this manner, the clams purge themselves of sand and mud and are then of better quality.

10-12. Hard-shell clams (called quahog, round clam, littleneck, or cherrystone) live on tidal flats and in water as deep as 50 feet. On the flats, they are harvested with rakes and hoes. In deep water, they are boated with tongs or power-driven dredges, depending on water depth and local regulations.

10-13. Pacific Coast clams (the razor, the pismo, and the hard-shell) are harvested in a manner similar to the Atlantic varieties. The shell of the razor clam is relatively soft and thin, and diggers must be careful not to damage them.

10-14. Since clam harvesting is conducted only "on the tide," little onboat handling is necessary. Diggers produce the largest in small increments and make delivery soon after boating the catch. If the clams are clear of contamination when caught, they will be the same when delivered to a processor.

10-15. Fresh clams for canning are put through a steam box. This process causes the shell to open, and the clam can be mechanically separated from its shell in machines designed for this purpose. Once out of the shell, the clam meats are moved to the cannery worktables. Here, the workers clip the siphon tips, slit the siphons open, separate the visceral parts, and wash out sand and silt. The meats are put through grinders and filled into cans. Final cooking is done in the can.

10-16. Clam procurement is controlled by Federal Specification PP-C-401, which classifies clams as follows:

- Type I, Fresh (chilled). This applies particularly to those clams marketed in the immediate area.
- Type II, Frozen. Clams intended for lengthy storage and/or shipment inland must be frozen to maintain quality.

10-17. Fresh clams may take on unnatural colors. In winter, when water temperatures go below 50° F., you may see a brownish-orange tint in the area around the digestive tract when the clams are first opened. Shucked clams that have stood for several days may develop a color that resembles the color of tomato sauce. The reason for this discoloration is not known; however, clams that develop this color are not acceptable.

10-18. Canned clams are inspected during processing at the canning establishment in order to determine the sanitation, type, freshness, and quality of the raw product. Clam juice should be fairly clear. Clams, either minced or whole, should have a clear, bright color. Clam products are packed almost exclusively in enamel-lined cans.

10-19. *Oysters.* Oysters are edible the year round, and the traditional bad periods reflect only the oyster's condition following spawning, a reduced seasonal food supply, or the storage and shipping problems brought on by hot weather. Oysters are one of man's best foods. Even the liquid is nutritious because it is high in albumin, mucin, and peptides, which are food fractions essential to an adequate human diet. Normally, females are fatter and meatier than males. Oysters do not die immediately after boating if they are kept cool and clean. Hence, they can be marketed to be served fresh on the half shell. Other forms are frozen and breaded. You will be more concerned with these latter forms, because these are the forms usually used by Air Force dining halls.

10-20. Holding market-size oysters on floats in shallow water near shore is referred to as "floating." Floating causes the oyster to take on water until it is in a bloated condition. Naturally, the water will be lost later, but, in the meantime, the operator will have been paid oyster prices for sea water. The buyer will end up with a greatly deflated product. The trick is illegal and oysters floated in this manner are not acceptable under Federal specifications. Federal specifications also prohibit buying "gapers," the name for dead oysters. When oysters die, the adductor muscle relaxes and allows the shell to open or gape; hence the term "gapers."

10-21. Upon arrival at the processing site, the oysters are washed by jets of water while passing up the conveyor and through a rotating screen washer to the storage bins. Oysters from these bins may be opened either by steam or by hand. Then the oysters are moved to the shucking room where the meat is removed from the shell, washed free of foreign matter, graded for size, and placed in containers. These oyster-meat containers are sealed watertight because intermediate handlers sometimes place them in water. If oysters are held in contact with fresh water for a long period, they will lose much of their soluble flavoring properties and will absorb considerable quantities of water. This processing is known as "drinking" or "soaking," and, like floating, is prohibited.

10-22. After sealing, the containers are packed in ice, because they must be kept below 34° F. to prevent spoilage. Packed in this manner, osyters will keep for about 2 weeks. Some of the shucked meats that are quick-frozen and held in subzero storage may be kept for a longer time.

10-23. Oysters are classified in three types as follows:

- Type I—Fresh (chilled).
- Type II—Frozen.
- Type III—Individual Quick Frozen (IQF).

Classes and sizes of oysters differ between the Eastern and Pacific Coasts. Table 2 gives the various sizes by count per container for each type.

10-24. It is quite possible that you will see breaded oysters, which is the third popular form. In this case, the shucked oysters are diverted to the breading facilities, where they are battered, breaded, frozen individually, and packed into institutional-sized containers. This product must be kept in frozen storage, but less than container quantities can be removed from the carton, and the balance can be returned to the freezer.

10-25. Canned oysters are prepared in the same way as are those intended for use as fresh oysters except that they receive some additional treatment. The washed meats are placed in popular-sized cans and are then commercially sterilized in steam-heated retorts. Diced or sliced meats are packed with all other stew ingredients and are precooked. This canned stew needs only reheating for use.

10-26. In addition to floaters and gapers, reject any oysters that are spawny, undernourished, sour, bloated, pink, elongated, or green-gilled. Fresh oyster liquor is of a translucent, milky color. Liquor from sour oysters, in which gas, acid, and

TABLE 2
CLASSES AND SIZES OF FRESH AND FROZEN OYSTERS

Class	Size (counts)	Type I - Fresh			Type II - Frozen (Regular)	Type III - Frozen (IQF)
		Count per gallon	Count per quart		Count per 6 pounds	Count per pounds
			Largest 1/	Smallest 2/		
I - Eastern or Gulf (Crassostrea virginica)	(a) Extra large	160 2/	-	44	Not more than 113	Not more than 19
	(b) Large (extra selects)	161-210	36	58	114-148	19-25
	(c) Medium (selects)	211-300	46	83	149-212	25-35
	(d) Small (standards)	301-500	68	138	213-352	35-59
	(e) Very small	Over 500	112	-	353 and over	59 and over
II - Pacific (Crassostrea gigas) 3/	(a) Large	Not more than 64			Not more than 45	Not more than 7
	(b) Medium	65-96			46-68	7-11
	(c) Small	97-144			69-101	11-17
	(d) Extra small	More than 144			102 and over	17 and over

1/ Least count.

2/ Maximum count.

3/ Largest oyster shall be not more than twice the weight of the smallest oyster within each size category.

odors have developed, will be opaque and grayish in color. You may also notice gas bubbles on the surface. The Federal specification for fresh or frozen raw shucked oysters contains allowances for maximum pieces of shell and for broken oysters.

10-27. There are two more factors peculiar to oysters: the appearance of small parasitic crabs, and the use of the pH of the oyster liquor as a means of determining the edibility of the oysters. The crabs are no problem. They are acceptable for Air Force purchase and, in fact, are a delicacy themselves. The pH of the liquor is a different matter. Although an oyster has been removed from the water, its metabolism does not stop. It will live for hours or days on the oxygen it carries, but all this time it is accumulating acids and the more acid, the lower the pH. Authorities have set the lower pH limit for edible oysters at 5.9. Since freshly shucked oysters range between pH 6.2 and 7.2, they have to gain considerable acid to become stale (5.7 to 5.9) or sour (below 5.7). You determine the pH of oyster liquor by using a pH meter; for field use, a Taylor Slide Comparator is satisfactory. The proper procedures for the use of the Taylor Slide Comparator were covered in a previous volume of this CDC.

10-28. **Crustaceans.** A crustacean is any of a class of invertebrates (Crustacea) that usually live in water, breathe through gills, and have a hard outer shell. All crustaceans are relatively high in protein and are excellent variations in our diet. The ones most widely consumed are shrimp, crab, and lobsters. Shrimp far outdistance the others in total catch; crab and lobster are becoming more common in inland markets, but their supply is somewhat limited. We shall discuss inspection requirements for each of these three.

10-29. *Shrimp.* Production extends around our entire continental coastline but the greater part of the catch is produced in the Southeastern and Gulf Coast States. Most shrimp caught for human consumption are immediately beheaded, and the edible, meaty tails are placed in cold storage on the boats. In some instances, the shrimp boat returns to dock as soon as its catch is boated; these fishermen do not behead their catch at sea but, instead, behead the shrimp immediately after unloading them at the dock.

10-30. Shrimp fishermen provide thousands of tons of several varieties. There are Latin names for the individual species, but the common names are sufficiently descriptive for most purposes. Brown, white, and pink shrimp represent the greater part of the harvest. Others, such as the Alaskan pink, the side-stripe, and the coon-stripe, are harvested in somewhat lesser quantities.

10-31. The white shrimp is whitish in color and is usually somewhat softer than the brown or the pink shrimp described below. Its tail is edged in green. The last segment of the tail is keeled on top and is edged in dark color.

10-32. The brown shrimp is usually tinted a brownish or orange hue. Its tail is edged in hues ranging from red-purple to sky blue. Two grooves about $^1/_2$ inch long are located adjacent to and on either side of the dorsal crest of the tail segment. (See fig. 32.)

10-33. The pink shrimp (also shown in fig. 32) resembles the brown shrimp but has a red or brown spot on each side at about the middle of its tail. In color it sometimes tends to be bluish or blue-gray, and its tail is edged in blue. The last tail segment bears a groove on either side of the central dorsal crest.

10-34. Shrimp are found in schools and are efficiently caught using otter trawls. With this fishing device, large quantities can be boated at one time. The nets are trawled 2 to 3 hours at a time or until the labor of boating is made worthwhile by the quantity in the catch. White shrimp inhabit comparatively shallow water (30-90 feet), while the grooved shrimp are found in deeper water (up to 600 feet). The grooved shrimp are harvested at night because they are found in much greater abundance at that time.

10-35. Sea-roving shrimpers stay out for several days to several weeks at a time. When a boat stays longer than 7 days, the catch is usually sent to shore by collection boats at 7-day intervals. This means that the catch must be transferred from hold storage to the other boat. Shrimp die soon after removal from the sea, and processing must begin at once. Obviously, there are inspection factors during the fishing trip.

10-36. As the shrimp are dumped on the deck, workers separate the shrimp from the trash picked up by the trawl. The boat crew may segregate the shrimp by size, but temperatures on the deck force the crew to work fast to preclude deterioration of the catch. If shrimp are not processed and placed in cold storage immediately, they suffer bacterial and autolytic spoilage. Another defect is black spot, a condition which affects the shell and which also causes unsightly damage to the flesh. Short drags with the trawl, immediate sorting and beheading, thorough washing, and quick icing reduce the incidence of black spot. Failure to follow these practices results in a cargo of substandard quality shrimp and one which you should be careful not to accept.

10-37. The shrimp are unloaded from the boat and washed. The unfit shrimp are culled while on the inspection belt. Heading is done at the picking tables (if not already done aboard the vessel). Examine a representative sample of the load to see that the shrimp are firm and in prime condition. Odor is a very good indicator of fresh shrimp. As you select samples, note any odors that are not

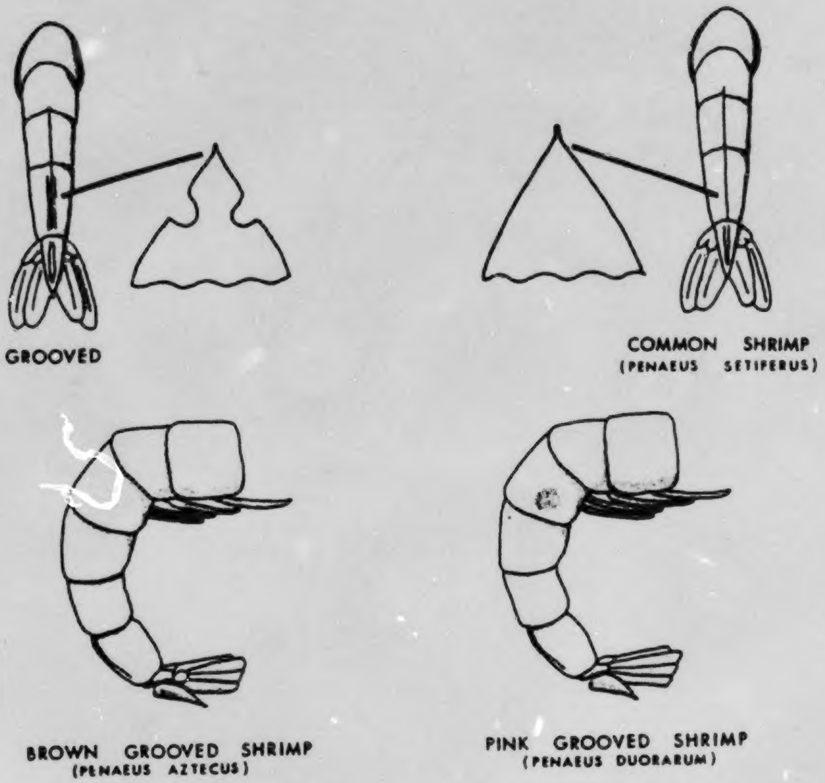

Figure 32. External features of common and grooved shrimp.

typical of fresh shrimp. Bear in mind that a ship's load usually consists of a catch made over a period of several days and that, even though a few of the shrimp are not in prime condition, the rest may be perfectly sound and acceptable.

10-38. The shrimp are unloaded at the plant into the receiving wash tank or onto a conveyor belt leading to the tank. The wash tank is used to wash the shrimp free of adhering dirt and to separate the shrimp from the ice used to refrigerate them.

10-39. Shrimp are sized by count per pound. There will be 15 or fewer large shrimp per pound, whereas there are more than 60 very small shrimp per pound. The purchase documents will specify the count of shrimp. Most plants now have sizing machines which sort shrimp into the different sizes. The purchase documents (including specifications or purchase description, DPSC clauses, and purchase orders) will specify the tolerances for undersize shrimp. Because the larger shrimp are the most expensive, you must see that these tolerances are not exceeded.

10-40. The procedures for determining size and tolerances are:

a. Select representative samples and spread the shrimp on a table so that you will be able to examine them visually.

b. Establish total count per pound (No. of shrimp/No. of pounds = count/pound).

c. Refer to examination tables of quality assurance provisions of the applicable specification for the category of defects pertaining to size.

10-41. There are three grades for shrimp stated in the U.S. Standards for Shrimp. These grades are based on the numerical total value remaining after subtracting points assigned to defects found from 100. Here is the way the grading system works. Individual defects have assigned point values, as stated in the right-hand column of table 3. You inspect the product and note all defects. Next you add all the numerical values assigned to the defects you found. Subtract this total from 100 and use this figure to arrive at a grade as shown below:

- U.S. Grade A or U.S. Fancy—not less than 90.
- U.S. Grade B or U.S. Good—not less than 80.

TABLE 3
SHRIMP GRADING—SCHEDULE OF DEDUCTIONS FOR FACTORS RATED BY SCORE POINTS

State	Factor	Description of quality variation			Deduct
		Dehydrated--exposed ends		Deslocation of meat	
		Frozen state	Thawed state	Thawed state	
Frozen and thawed	Dehydration	Up to 5 percent	None	None	0
		5.1-15.0 percent	Up to 2.0 percent	Slight	3
			2.1-5.0 percent	Moderate	6
		Over 15.0 percent	Over 5.0 percent	Marked	11
		(Percent by count of *total sample*.) Apply the *one* highest deduction only.			
Thawed	Deterioration	Off-odor, overall sample:			
		Slight			2
		Moderate			6
		Marked			21
		Any excessive, each 1 percent or fraction (percent by count)			5
	Black spot on shell or loose membrane only.	Shell affected, but not meat.			
		Not over 5 percent			0
		Each additional 5 percent, or fraction (percent by count)			1
	Black spot on meat	None			0
		Not over 3 percent			1
		3.1-5.0 percent			2
		Each additional 5 percent, or fraction (percent by count)			2
	Broken, damaged, and pieces	Not over 1 percent			0
		1.1-3.0 percent			2
		Each additional 3 percent, or fraction (percent by weight)			2
	Legs, loose shell, and flippers.	Not over 3 percent			0
		Each additional 3 percent, or fraction (percent by count)			2
	Heads and unacceptable shrimp.	Not over 1 percent			2
		Each additional 1 percent, or fraction (percent by count)			3
	Extraneous material	1 piece			1
		2 pieces			2
		over 2 pieces			4
	Uniformity of size	Slightly large and slightly small: Each 3 percent, or fraction			1
		Exceedingly large and exceedinly small: Each 3 percent, or fraction (percent by count--based on actual count per pount of sample).			2
Cooked	Texture	Tough, dry, or mushy:			
		Slight			2
		Moderate			4
		Excessive			11

[1] This schedule of point deductions is based on the examination of sample units composed of: (a) the contents of an entire package or (b) sufficient packages to provide a sample unit of 2 pounds or more, declared net weight.

- U.S. Grade C or U.S. Commercial—not less than 70.

This grade is assigned only after the product has passed a flavor and odor examination (organoleptically) as required by U.S. Standards. The military buys only U.S. Grades A and B.

10-42. There are several different specifications that apply to shrimp. These specifications state the requirements for headless, peeled, peeled and deveined (P & D), breaded round, breaded butterflied or split, portions, and cooked shrimp. These different classifications of shrimp are procured as either chilled, frozen, individual quick-frozen (IQF), or canned.

10-43. Most shrimp catches are frozen as headed, unpeeled shrimp after they have been washed, sized, and inspected. They may later be thawed for further processing. In freezing, filled packages are placed on portable racks and are conveyed to the freezer. After they are frozen solid, they are glazed. Usually the open packages of frozen shrimp are placed on a conveyor which carries them under a stream or spray of chilled potable water. After passing under this spray, the packaged shrimp are inverted and are replaced on the freezer racks or packed in master cartons and then returned to the freezer. The purpose of inverting is to allow the free water in the package to freeze on the top of the package; thus, there is a covering of ice on both the top and bottom of the pack. If the shrimp are to be IQF, they are frozen individually in continuous freezing cabinets and are then glazed before they are packaged.

10-44. Cooked shrimp are handled as peeled (regular or deveined), chilled shrimp. They are cooked by immersion in a boiling salt solution. After cooking, the shrimp must be quickly drained and washed in ice water to lower their temperature. When the shrimp have cooled to 35° F. or below, they are drained and inspected for broken shrimp, pieces of shell, and other objectionable conditions.

10-45. Breaded shrimp are prepared from chilled or frozen shrimp. Most breaded shrimp for Armed Forces purchases are prepared from fresh, chilled shrimp. The headed shrimp must be properly washed, culled, peeled and deveined. The fantail and adjoining shell segment may be left on, if this procedure is specified.

10-46. The purchase description gives detailed quality requirements for all the coating ingredients for breaded shrimp. Breading must be added to the shrimp in an amount allowed for the specified coating range. The amount of coating is determined before the product is frozen by drawing and examining samples in accordance with the inspection documents and MIL-STD-105, *Sampling Procedures & Tables for Inspection by Attributes*. Batter and breading must competely and evenly cover the shrimp meats (the fantail need not be covered).

10-47. *Crab*. The crab's exoskeleton is a hardened substance which is periodically discarded as the crab grows in size. When the shell becomes too confining for the growing crab, the shell splits at its seams, and the crab backs out of it. In this denuded stage, crabs are called soft shell and are preferred eating, because shell and all are edible. For commercial purposes in canning, soft-shell crabs tend to be watery and poor in texture; and, therefore, they are marketed only as fresh crabs. This water absorption is brought about by the necessity for the crab to inflate its size so that the new shell will be large enough for him when it hardens. The breeding season is synonymous with the molting period, because the male must insert the sperm under the soft shell mantle for the female to use it to fertilize the eggs as she produces them. The female carries the eggs in cluster under her tail until they hatch. Since she heads for the open sea with her eggs, and because some States prohibit female take, market crabs usually are males.

10-48. Several species of crab dominate the market; in the Atlantic and Gulf Coast areas, it is the blue crab in both the soft- and hard-shell stages. On the Pacific side, we find Dungeness, Rock, and King crabs, with the latter predominating. The blood of crabs perfuses the tissue rather than being confined in vessels, making it next to impossible to properly bleed the crab during processing. If crabs are dead or only barely alive when processing starts, they will not be acceptable as food. Consequently, they are kept in live wells and are maintained in a completely healthy state before being cooked alive. Another factor is that it is difficult to remove crab meat from the shell if it is not thoroughly cooked. Cooking does not appreciably change the nutrient content.

10-49. Crab fishing could be termed a "piecework" operation because the crabs are not boated in vast quantities. The greater part of the blue crab harvest is made by using pots, although some are caught with baited trotlines, dredges, or otter trawls. Dungeness and King crab harvests are made almost entirely by means of pots. In some fishing grounds, particularly the Alaskan, the number of pots per boat or per fisherman is rigidly controlled.

10-50. Crabs must be kept alive until they are processed. Therefore, they are held in tanks aboard the fishing boat, with continuous circulation of fresh seawater to assure an adequate oxygen supply until they are unloaded. Live blue crabs are cooked whole in steam pressure cookers or in boiling water. Upon removal from the cooker, they are cooled; then workers remove the shell, viscera, and claws, and pick the meat from the shell preparatory to canning. Because cooked crab doesn't store satisfactorily frozen, some of the blue crab meat is canned for shipment and storage, but most of the cannery output is marketed as fresh, cooked crab at local markets.

10-51. The Pacific Coast Dungeness crab is much larger than the Eastern Blue and is easier to process. The crabs can be butchered before cooking. Cannery workers cut the carapace (body shell) in half and remove the visceral parts and gills. Then the crab halves are cooked in boiling water. After cooking, workers shake or pick the meat from the shell and send it through a washing station to remove bits of shell or debris. After inspection, the meat is canned for storage or shipment. The filled cans must be kept in cold (32°F. to 40°F.) storage until they are to be used.

10-52. The King crab, the last species with which we are concerned, gets its name from its size. The crabs may weigh more than 20 pounds and span as much as 5 feet from tip to tip of their outstretched legs. Only males may be taken legally, and they must be in prime condition and healthy before being processed. Because of the distance between the fishing grounds and the canneries and markets in the "lower forty-eight," King crab must be processed before shipment. The crabs are butchered, cooked, washed, and chilled before canning. Mechanical equipment, such as rubber rollers, breaks the shells so that the meat may be extracted or forced from the shell. The meat is again washed, inspected, cooked further in boiling brine, spray-washed, reinspected, and passed to the packing table. King crab draws a premium price, and processors work to maintain the high quality of the product, so that their sales will not suffer in the competitive market.

10-53. King crab is much more suitable for freezing and storage than are other crab species. Preparation for freezing follows much the same routine as for canning, except that the meat is chilled before removal from the shells. This enables extraction with less breaking up of the sections. After extraction, the meats are incorporated into large blocks (250 ounces meat and 24 ounces water), inspected, packed in storage containers, frozen, glazed, and shipped. Users simply saw the frozen blocks into desired portions for use.

10-54. Crab products are classified under Federal Specification PP-C-566 as follows:

- Type I—White or body crab meat.
- Type II—Claw crab meat.
- Type III—Body and claw crab meat.

Beyond these basic classifications, you must know that soft-shell crabs must be alive and properly packaged according to the purchase agreement. If soft-shell is called for, they must be true soft-shell crabs—not paper-shell nor buckram crabs. Frozen hard-shell crabs must be dressed and kept at a temperature of 0°F. or below. The wrapping must be such that it will prevent dehydration or oxidation.

10-55. Canned crabmeat naturally has a salty, fishlike odor. The odor of decomposed crabmeat is readily discernible; even the slightest decomposition produces a penetrating and nauseating odor. Small orange-yellow globules resembling fish eggs are sometimes found in canned crabs. They are eggs and are perfectly wholesome. Small quantities of a light yellow fat may also be found. This fat indicates that the crab was large and fully mature. Care should be taken to distinguish both eggs and fat from the entrails.

10-56. *Lobster.* The lobster is the most glorified member of the shellfish family. There is a notable difference between the Northern or Maine variety and the Spiny or Rock types caught along the South Atlantic, the Gulf, and the Pacific Coasts. The Northern lobster is famous for its proportionately huge front claws. The Spiny lobster, on the contrary, has no such crushing claws but grows long spiny feelers in their stead.

10-57. Lobster fishermen lower baited pots to the sea bottom and locate their position with marker buoys and flags. Some spiny lobsters are harvested with dip nets by fishermen in small boats. After being caught, the lobsters are accumulated in holding pounds to permit the conditioning of the new shell on those that have recently molted, and to enable the marketing of the others under better price conditions. Some catches are stored in floating crates with sea water circulating freely through them.

10-58. Lobsters are kept alive in holding wells until time for cooking. Shippers either tie the claws with wire or place a wooden peg in the claws, which keeps the lobster from cutting the legs off his bedmates. Lobsters are packed live into barrels layered with ice and seaweed for shipment to inland markets. Spiny lobsters are often handled like shrimp since they have no huge claws filled with edible meat. The body and tail are separated, and only the tail is prepared for eating. The lobster tail may be frozen (either raw or cooked) and shipped to market.

10-59. Only small lobsters are usually canned. They are cooked and picked. The meat is cleaned of clotted blood and other offal, and is then washed and drained. After the meat has been drained, it may be dipped in brine which contains a small amount of citric acid to keep it from blackening in the can. The meat is manually packed into C-enameled cans; lining, bag, or parchment paper is used to protect the meat against blackening. The tail meat is usually placed on the bottom, the claw meat on top. Salt or brine, and occasionally spices, are added. After filling, the cans are exhausted of air for about 10 to 12 minutes, then are sealed, retorted, cooled, and labeled.

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Dairy Products

MORE TECHNOLOGY and controls have been implemented for dairy products than for any other natural food. Strict sanitation codes control most milk produced today. Automatic milking machines milk the cow after the udder is sanitized; then, machines pump the milk to holding tanks; later refrigerated tank trucks take it to a processing plant. These procedures virtually eliminate environmental contamination. At the processing plant, milk is tested for quality and wholesomeness. Further, it is processed under the vigilance of plant, city, State, and Federal inspectors. Few other food products undergo the rigid inspections required of dairy products.

Milk and other dairy products are among the most important foods used by the armed forces. Let us consider the number of dairy products we consume in a day. If we have cereal for breakfast, we use milk or cream with it. If we have an omelet, we may have cheese with it, and the omelet may be fried in butter, or if we have fried or scrambled eggs, they may be cooked in butter. If we have toast, we have butter with it. If we have hotcakes, the batter contains some form of milk. For our beverage, we may have a glass of fresh milk, or coffee with cream, fresh milk, evaporated milk, or dehydrated milk. For our noon meal, we may have a cream soup, butter, cottage cheese salad, macaroni cheese casserole, and fresh milk or cream with our coffee. For supper, we may have fresh milk again, and ice cream for dessert. As a snack, we may have a malted milk. Not only do we use dairy products directly in such ways as these, but we also use them indirectly in such foods as pastries, breaded foods, and many other cooked foods. Milk, then, is a significant component of our daily diet.

3. You, the veterinary specialist, must not only insure that the proper quality and quantity of milk and milk products are procured, but you must also prevent the use and consumption of unsafe products within the military establishment. To properly perform these important tasks, you must have a basic understanding of the quality controls placed on dairy products, including the procurement quality assurance procedures used by the military. You should also be familiar with the microorganisms common to dairy products and the results of their presence in those items. Finally, you must be familiar with the various laboratory examinations used in the analysis of dairy products to determine quality, wholesomeness, and contract compliance.

11. Quality Controls and Inspection of Fresh Dairy Products

11-1. A thorough inspection system, which begins on the farm and continues through all aspects of milk production, processing, shipping, and storage, is necessary to insure proper quality controls on the dairy products purchased by the military. You could be involved in any of the aspects of this overall inspection plan, depending upon the responsibilities of the Base Veterinary Office to which you are assigned. Whatever your job, though, you will need to have a good knowledge of the product requirements set down by the military. These requirements can be found in a variety of publications, including contracts; specifications; the *Grade "A" Pasteurized Milk Ordinance,* AFM 74-15, *Procurement Quality Assurance,* Appendix A, *Fresh Dairy Products;* as well as the various contracts let by the military. The sources of information on product requirements that you will use most frequently will be AFM 74-15, Appendix A, and the applicable contracts. We will discuss AFM 74-15 in a later section of this chapter. Now, let's turn our attention to military contracts.

11-2. **Contracts.** We cannot overemphasize the importance of contracts, or any inspection documents. If you lack an understanding of what constitutes inspection documents or if you can't interpret them, you will fail as an inspector. Contracts for dairy products are prepared and awarded by the purchasing and contracting officer, although some contracts may occasionally be let by DPSC. The contract usually consists of the primary contractual document accompanied by and/or referencing

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other related documents. The primary contractual document stipulates special requirements, such as the following:

- *a.* Size of container.
- *b.* Type of container.
- *c.* Grade of the product to be procured.
- *d.* Quantity to be delivered.
- *e.* Time of delivery.
- *f.* Place of delivery.
- *g.* Other specific requirements.

11-3. Related documents might be referenced in a contract (thereby making them a part of the contract) or may be attached to the contract. Collectively, the contract and the referenced (or attached) documents make up the Purchase Instrument. Let us consider what documents might be referenced or attached to a contract.

- *a.* Subsistence Master Solicitation (SMS).
- *b.* Buyer's guide.
- *c.* Federal and Military Specifications.
- *d.* Amendments.
- *e.* Purchase descriptions.
- *f.* DOD deviations.
- *g.* DPSC clauses, articles, conditions, and special provisions.

11-4. Procurement Quality Assurance Procedures. The instructions to assure uniformity in the administration of the procurement quality assurance provisions of contracts for fresh dairy foods are found in Appendix A of AFM 74-15. This directive outlines concepts and policies as well as prescribes the procedures and techniques necessary to perform uniform procurement quality assurance. Since a large part of the Veterinary Service's inspection responsibility deals with dairy products, you must familiarize yourself with the information presented in AFM 74-15. Although it is needless to reproduce all the material in AFM 74-15, we will discuss the general aspects of this directive and present some of the duties of veterinary food inspectors who are responsible for various aspects of the procurement quality assurance of fresh dairy products purchased by the military.

11-5. There are three inspector positions necessary to properly implement procurement quality assurance:

- Administrative Control Inspector (ACI).
- Origin Inspector.
- Destination Inspector.

You may be required to fill any one or a combination of these positions. Let's discuss them and learn their function and how they coordinate their activities.

11-6. *Administrative control inspector (ACI).* The ACI, who often serves as the origin inspector at a prime contractor's plant, is responsible for the administration of the procurement quality assurance procedures for the contractor(s) for which he is assigned. He will maintain liaison with the origin inspector(s), if any (sometimes the ACI functions as origin inspector for a prime contractor), and the destination inspector(s). Some of the ACI's specific duties are:

a. Develops a sampling plan for Government laboratory testing. The ACI arranges for the routine selection and submission of samples for chemical and bacteriological testing. The frequency of sampling is derived from AFM 74-15, Appendix A, and the quality history of the contractor.

b. Arranges for origin and/or destination sampling for laboratory testing. He coordinates his sampling plan with origin and destination in order to insure its proper use.

c. Provides the destination inspector with current, reliable data on product quality so that he can fulfill his inspection and sampling responsibilities at his installation.

d. Determines if any quality control problems have been discovered at either origin or destination.

e. Assures that the contractor has provided accurate tare weights and production codes to each destination.

11-7. *Origin inspector.* This inspector is responsible for conducting the procurement quality assurance procedures and coordinating all actions and results with the ACI. When not acting as ACI, i.e., when he is origin inspector at a subcontractor's plant, he will perform the following duties:

a. Provides data to the ACI on the contractor's quality control.

b. Coordinates any necessary changes that the ACI has arranged in the sampling plan.

c. Assists the ACI with any problems related to accurate tare weights and production codes at the plant.

11-8. *Destination inspector.* The destination inspector's duties comprise an integral part of the quality assurance of fresh dairy products. His primary function is to supply the ACI with current, reliable data on the contractor's quality control. In other words, the destination inspector performs examinations on dairy products, as well as submits samples for laboratory testing. The frequency with which the destination inspector performs his duties is determined by the ACI, and is based on the quality history of that contractor. Our discussion will reflect the *normal* frequency. The number of samples and examinations will either increase or decrease in frequency, depending on the reliability of the contractor's quality control. There are six main tasks involving sampling and examining dairy products that the destination inspector must perform in order to gather the information necessary to evaluate quality and contract compliance of diary products:

a. Examination of Net Weight and Volume. Once each week you should examine each line item (each size container) for net weight. Normally, dairy products are weighed; however, you, as the inspector, should occasionally perform a volumetric examination to check the accuracy of the tare weight used in your net weight examinations.

b. Determination of Temperature on Delivery. You should check the temperature of the shipment daily on each delivery. Be sure to take temperatures throughout the load to assure it meets the requirements.

c. Determination of the Age of the Product on Delivery. You should check the code date during the temperature examination to assure that the shipment meets the requirements.

d. Determination of Keeping Quality. You conduct this examination to determine whether or not the milk is of sufficient quality to stay fresh for the stated shelf life. This text provides a valuable source of feedback information on plant problems related to excessive contamination of fresh dairy products. The product should be stored at a constant 40° F. preferably, or at 45° F. The product should be tasted either 7 days after the date of pasteurization if stored at 40° F. or 5 days after pasteurization at 45° F. The presence of winey or fruity flavors is the first indication of spoilage by psychrophilic organisms.

e. Collection and Submission of Dairy Samples. You must collect dairy samples on a routine basis, as arranged by the ACI, and submit them to the appropriate Army medical laboratory for bacteriological and/or chemical analysis. You should pack your specimens in dry ice in accordance with the instructions in Volume 2 of this CDC. The correct number of DD Form 1222, properly completed, should accompany the shipment.

f. Organoleptic Examination. You should check the product for off-odor and off-flavor as you check the temperature.

11-9. The data obtained from the laboratory tests and the examinations performed at destination are used to help compile the *contractor's quality history file.* The ACI uses this file to determine the frequency of examinations and sample submissions for the destination and origin inspectors to use. We will not discuss the rules for determining the frequencies here because Appendix A of AFM 74-15 states them in detail.

12. Microorganisms Common to Dairy Products

12-1. The action of microorganisms results in deteriorative changes in fresh dairy products. We will discuss some of the common microorganisms, their importance, and the results of their presence in fresh dairy products. This background information will serve as a basis for a later discussion of the laboratory analysis of dairy products.

12-2. The microorganisms of dairy products of most concern to us are: lactic-acid-producing bacteria, spore-forming bacilli, coliform bacteria, and yeasts. Your understanding of these microorganisms will help you perform inspections on the products, request laboratory analysis, interpret the results of the lab analysis, and use the lab results to correct discrepancies in production. Although some bacteria are necessary to produce such dairy products as sour cream, buttermilk, cottage cheese, and cheese curd, the growth of some bacteria in our dairy products can cause disease or off-odor and off-taste.

12-3. **Lactic-Acid-Producing Bacteria.** Lactic-acid-producing bacteria are divided into three main groups: (1) streptococci, (2) staphylococci, and (3) lactobacilli. They grow rapidly at temperatures from 60° F. to 90° F. and inhibit the growth of many other organisms.

12-4. *Streptococci.* These spherical-shaped bacteria, which occur in chains, are the primary cause of sour milk. But their presence in milk is not all bad, for these same bacteria are used as "starters" in making butter, cheddar cheese, and cultured buttermilk.

12-5. *Staphylococci.* Staphylococci are commonly found in aseptically drawn milk. Some species of this bacteria are thermoduric (heat-resistant) to the extent that they can survive pasteurization temperatures, particularly high-temperature, short-time (HTST) pasteurization. Other species are pathogenic, and cause boils, wound infections, and mastitis in cattle. Still others produce a heat-stable enterotoxin (a biological poison), which is a common cause of food poisoning. Since staphylococci can survive pasteurization temperatures and are extremely dangerous if not properly controlled, we must make sure that milk is kept properly refrigerated at temperatures below that at which these bacteria will grow. Temperatures should be no higher than 50° F. before pasteurization and no higher than 40° F. after pasteurization.

12-6. *Lactobacilli.* Lactobacilli are commonly found in milk. They ferment lactose to lactic acid and are used in the production of certain cheeses. One species, *L. thermophilus,* is a thermophile and can be found in pasteurized milk.

12-7. **Spore-Forming Bacilli.** These are rod-shaped bacteria, highly resistant to heat, and commonly found in the soil. The presence of spore-forming bacilli in milk is a good indication that the cow was not properly cleaned before milking, that dust in the milking barn has gotten into the milk, or that the utensils used in handling the milk were dirty. Since they are resistant to heat, pasteurization does not generally kill these bacteria. The most effective way to control spore-forming bacilli is to make certain that the establishment concerned constantly practices proper sanitary procedures.

12-8. **Coliform Bacteria.** Coliform bacteria are short, gram-negative, rod-shaped organisms. You can expect to find them in nearly all raw milk. In fact, they are so common in raw milk that if you do not find them you will be wise to suspect that an agent has been added to destroy them. Their presence in large numbers is an indication of poor or faulty sanitation in both raw and pasteurized milk. The presence of coliform bacteria in raw milk may be due to any one or more of a number of reasons, such as:

a. Poorly sanitized equipment and utensils.
b. Dirt falling into the milk or milk containers.
c. Manure falling into the milk or milk containers.

12-9. Coliform organisms are normally destroyed by proper pasteurization. How is it possible then for them to be in milk after pasteurization? It's really quite simple: the product has been recontaminated after pasteurization. This problem could occur in a number of ways, for example:

a. Improper cleaning and sanitizing of equipment, utensils, and piping.
b. Improperly covered containers.
c. Condensation dripping into the product.
d. Contaminated bottles or bottle caps.
e. Handling of the milk or processing equipment by employees who do not practice good personal hygiene.

12-10. The following preventive measure must be followed if coliform bacteria are to be controlled. Milk not delivered to the processing plant within 2 hours *must be* cooled to at least 50°F. and held at a temperature no higher than 50°F. until delivered. If milk is not properly cooled, the bateria will grow very rapidly. Furthermore, the milk may contain the enterotoxin-producing staphylococci, which are not destroyed by pasteurization. This enterotoxin is capable of causing food poisoning in people who consume infected milk; therefore, proper sanitary procedures and proper temperatures must be maintained if we are to control coliform bacteria.

12-11. **Yeasts.** If we were to place a yeast organism and a bacterium side by side under a microscope, we would see that the yeast is much larger. Yeasts are from 10 to 15 microns in size, while bacteria are from 0.3 to 5 microns in size. Despite the size difference, the structures of the two are similar. Yeasts can tolerate a rather high acidity (pH 3.5), and they use lactic acid for energy. They affect dairy products in may ways. For instance, certain species of yeasts, because of their strong fermentative and oxidative abilities to metabolize carbohydrates, can cause gassiness in sweetened condensed milk. In addition, yeastiness (yeast flavor) is common in old cream and often carries over to butter when old cream is used in its manufacture. Also, some yeasts cause changes in cheese, such as a yeasty flavor and flat elongated holes commonly referred to as "slit-eyes" or "fish eyes." Once again, temperature is important in controlling this organism. Pasteurization temperatures usually destroy yeasts in dairy products.

12-12. In short, dairy bacteriology is important to us for four major reasons:

(1) Beneficial microorganisms can develop desirable flavors and other desirable characteristics in certain dairy products such as milk an cheese.

(2) Pathogenic microorganisms may be spread through dairy products and result in disease to the consumer. Tuberculosis, typhoid fever, and septic sore throat are examples.

(3) Detrimental microorganisms may cause undesirable changes, such as deterioration, undesirable flavors, undesirable odors, or spoilage, without being pathogenic.

(4) Some microorganisms are neither beneficial nor detrimental, but add to the total bacterial count and result in a product that fails to meet sanitary requirements.

13. Analyses of Dairy Products

13-1. The analysis of dairy products involves the product from its early stages of manufacture to the finished product. You may have already had an opportunity to request that the laboratory perform certain analyses, or perhaps you have run some yourself. Regardless of the reason for these analyses, we cannot request or perform such tests without first knowing the properties of milk and the tests used to analyze these properties and to determine a wholesome product.

13-2. **Properties of Milk.** In order to protect our milk supply from adulteration and to provide the best product available, you need to know the properties of milk. These properties can best be described in terms of color, flavor, odor, and specific gravity. You submit samples of dairy products for laboratory analysis to insure that the product received is of the quality desired. By knowing the normal properties, you can identify the abnormal.

13-3. The normal color of milk varies from light cream to light bluish-white. Milk with a high fat content and high carotene content is more creamy in color. Other constituents that affect the color of milk are casein, salts, and riboflavin.

13-4. Milk is examined organoleptically for off-odor more often than for any other factor. The reason is that if inspectors tasted raw milk they would expose themselves to the danger of contracting a milk-borne disease. Inspectors can usually taste properly pasteurized milk safely, and they can smell a can or carton of milk as soon as it has been opened to check for milk odor. Normal milk has a pleasant odor and a sweet lactose flavor.

13-5. The normal specific gravity of milk varies from 1.027 to 1.035, with an average of 1.032 at 60°F. An instrument called the lactometer is used to determine specific gravity. Specific gravity is determined for the purpose of detecting whether the milk has been grossly adulterated with water. The test can also be used to estimate solids-not-fat and total solids in milk.

13-6. **Laboratory Tests.** There are three types of laboratory tests that are performed on fresh dairy products: chemical, physical, and bacteriological. For the most part, the different tests are usually performed by Army Medical Laboratories at the request of the destination inspector (following the frequency schedule determined by the ACI). However, there are some base veterinary facilities that are responsible for performing certain laboratory examinations on dairy products. Whatever your responsibility, you will need to know what types of tests are necessary to determine quality, wholesomeness, and contract compliance; if you submit samples, you will need to know what tests to request and how to interpret them; if you perform basic lab tests yourself, this chapter can serve as a limited procedural reference guide.

13-7. *Standard plate count (SPC).* This bacteriological examination (outlined in Volume 2 of this CDC) is a means of determining the number of bacteria within a food item, for our purposes, within a sample of dairy products. Each dairy product has a maximum allowable number of bacteria (counted as colonies) per unit of measurement; for example, X number of colonies per gram or mililiter of sample. The tolerance for each type of product is listed in the applicable specification, and sometimes quoted in military contracts. The SPC examination can be used as an indication of the quality of the product; a low quality item will have a high bacterial count while a high quality item will have a low bacterial count.

13-8. High SPC levels are generally indicative of contamination after the pasteurization of the product. Often, the product is put into improperly sanitized containers, or the processing equipment may be dirty; either way, the result is a contaminated product.

13-9. *Coliform test.* This test is designed to determine the presence and number of coliform organisms in dairy products. The two most important types are *E. coli*, found in the gastrointestinal tract of man and animals, and *Aerobacter aerogenes*, found in dust and soil. Since coliforms are usually destroyed by pasteurization, their presence in fresh dairy products indicates postpasteurization contamination. The source of contamination can be any of the following:

- Improper sanitation of equipment.
- Contamination of the product with water, raw milk or other materials contaminated with coliforms.
- Improperly covered containers.
- Contaminated cartons.
- Hand contamination of product contact surfaces.

13-10. Let's look at the procedures for performing the coliform test:

a. Equipment and reagents:

(1) Desoxycholate agar.
(2) Eosin Methylene Blue agar (EMB).
(3) Wire inoculating loop.
(4) Sterile 11-ml pipette.
(5) Incubator..
(6) Petri dishes.
(7) Distilled water.
(8) Quebec colony counter.

b. Preparation of media. Autoclave the EMB agar at 121°C. for 20 min. at 15 pounds pressure. The desoxycholate agar cannot be autoclaved because excessive heat is detrimental. This agar will be sterilized if it is heated to boiling, and is stirred frequently while it is being dissolved in distilled water.

c. Procedures:

(1) Place 1 ml of the sample to be tested into each of three petri dishes.

(2) Pour about 10 ml of sterile desoxycholate agar (cooled to 44°C to 46°C) into each petri dish, rotate to mix, and allow to harden.

(3) After the agar in the dishes has hardened, cover with a thin layer of desoxycholate agar and allow it to harden.

(4) Incubate the inverted petri dishes at 35°C. for 24 hours.

(5) Count the colonies in all three plates and average the total; report as colonies per ml or colonies per gram, depending on whether a liquid or a solid (semisolid) product was tested. This part of the test gives you the count for nonspecific coliforms. Let's continue and see how to determine if *E. coli* is present in the sample.

(6) Select some typical colonies from the desoxycholate plates and streak them, with wire loops, onto several EMB plates.

(7) Incubate the EMB plates, inverted, at 37°C. for 18 to 24 hours.

(8) The growth of *E. coli* is demonstrated by the presence of a green sheen on the plate.

13-11. *Babcock test for butterfat content.*

Butterfat is an important ingredient of most dairy products; the percent of butterfat of an item determines, in part, its cost. For this reason, the butterfat content of dairy products is of great concern to veterinary inspectors. The butterfat requirements for any of the many dairy products purchased by the military are listed in the applicable specifications. The Babcock test can be used to measure the butterfat content of a dairy product sample, whether it is liquid or semisolid. Here are the procedures for testing milk:

a. Equipment and Reagents:

(1) Bottle, butterfat determination, milk test, Babcock.

(2) Burette, automatic, 17.5 ml.

(3) Bottle and pipette, acid, 2-liter.

(4) Sulphuric acid, technical.

(5) Centrifuge, laboratory size, 110-volt, AC-DC.

(6) Water bath deep enough to cover fat column.

(7) Dividers (nonstandard, purchased locally).

(8) Pipette, butterfat determination, milk.

b. Procedures:

(1) Mix the sample thoroughly by pouring it back and forth several times between the sample bottle and a mixing glass of suitable size, and adjust the temperature between 16° and 21°C.

(2) Immediately after mixing the sample pipette, put 17.5 ml of the sample into a milk-testing bottle by means of a 17.6-ml pipette (about 0.1 ml will cling to the inside surface of the pipette). To remove the drop remaining in the pipette tip, blow through the pipette after free flow has stopped.

(3) Add 17.5 ml of sulphuric acid (temperature 15° to 20°C.); hold the bottle at an angle and rotate it to wash down any milk that clings to the inside of the bottle neck. Add the acid slowly in three portions, and shake the Babcock bottle after each addition.

(4) Shake the bottle in a circle at fairly rapid speed until its contents are uniformly brown. Then shake it vigorously for about 30 seconds.

(5) Centrifuge for 10 minutes (1100 RPM).

(6) Add enough hot water (above 60°C.) to raise the level of the contents of the bottle to the base of the bottle neck.

(7) Centrifuge for 2 minutes (1100 RPM).

(8) Add enough water (above 60°C.) to float the fat column well up into the neck of the bottle.

(9) Centrifuge for 1 minute (1100 RPM).

(10) Place the bottle in a water bath at 54° to 60°C. (be sure that the water is above the top of the fat column) and leave it for 5 minutes.

(11) Remove the bottle from the water bath. Hold it in a perfectly vertical position, and set the spread of a pair of dividers so that one point coincides with the extreme lower part of the lower meniscus and the other part coincides with the upper line of the top meniscus. Set calipers on the blank side of the bottle neck to ensure utmost accuracy. Set one point of the calipers at the zero mark on the bottle, and read directly the percentage of fat from the scale on the neck of the bottle coinciding with the upper point of the dividers.

(12) If you use very warm acid (above 21°C.) which has been in a warm room, add a small amount at a time to the sample; after each addition, shake the sample thoroughly until the desired coffee color is produced. Preferably, the acid should be cooled in a refrigerator.

(13) If the milk is warm, add acid in the manner described above.

(14) Both of the above conditions require less acid than a condition in which the milk and acid are between 16°C. and 21°C. A full amount of warm acid may cause charring and floating of curd particles in the fat column.

(15) Discard all analyses in which curd or charred material is in the fat column, or in which the reading is indistinct.

13-12. The butterfat content makes up only a portion of the total solids present in dairy products. The rest of the solids are classified as solids-not-fat. The Army medical laboratories perform determinations upon request for solids-not-fat, butterfat, and total solids when samples are submitted for testing. But, to properly interpret the results of the laboratory tests you must check the contracts and the applicable specifications to determine the required percentages.

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WORKBOOK

Animal Service; Military Working Dogs; Fresh Fruits and Vegetables,
Waterfoods, and Dairy Products Inspection

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This workbook places the materials you need *where* you need them while you are studying. In it, you will find the Study Reference Guide, the Chapter Review Exercises and their answers, and the Volume Review Exercise. You can easily compare textual references with chapter exercise items without flipping pages back and forth in your text. You will not misplace any one of these essential study materials. You will have a single reference pamphlet in the proper sequence for learning.

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If you have any questions which you cannot answer by referring to "Your Key to Career Development" or your course material, use ECI Form 17, "Student Request for Assistance," identify yourself and your inquiry fully and send it to ECI.

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STUDY REFERENCE GUIDE

1. *Use this Guide as a Study Aid.* It emphasizes all important study areas of this volume. Use the Guide for review before you take the closed-book Course Examination.

2. *Use the Guide for Follow-up after you complete the Course Examination.* The CE results will be sent to you on a postcard, which will indicate "Satisfactory" or "Unsatisfactory" completion. The card will list *Guide Numbers* relating to the items missed. Locate these numbers in the Guide and draw a line under the Guide Number, topic, and reference. Review these areas to insure your mastery of the course.

Guide Number

Guide Numbers 400 through 413

400 Introduction to Animal Service; The Veterinary Small Animal Clinic; pages 1-11

401 Animal Diseases: Epidemiology; pages 11-14

402 Animal Diseases: Communicable Diseases That Are Not Zoonotic; Noncommunicable Diseases; pages 14-17

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410 Introduction to Waterfoods; Fresh and Frozen Fish; pages 56-61

411 Shellfish; pages 61-68

412 Introduction to Dairy Products; Quality Controls and Inspection of Fresh Dairy Products; Microorganisms Common to Dairy Products; pages 69-72

413 Analyses of Dairy Products; pages 72-74

CHAPTER REVIEW EXERCISES

The following exercises are study aids. Write your answers in pencil in the space provided after each exercise. Immediately after completing each set of exercises, check your responses against the answers for that set. Do not submit your answers to ECI for grading.

Objective: To understand the complete operation of the zoonoses control clinic and animal quarantine procedures related to privately owned animals.

MODIFICATIONS

Questions 1-31 of this publication has (have) been deleted in adapting this material for inclusion in the "Trial Implementation of a Model System to Provide Military Curriculum Materials for Use in Vocational and Technical Education." Deleted material involves extensive use of military forms, procedures, systems, etc. and was not considered appropriate for use in vocational and technical education.

32. Define epidemiology. (2-2)

33. What are three physical nonliving agents that can cause diseases? (2-4)

34. How might a host combat invading organisms? (2-5)

35. What are the common portals of entry for an organism into the host? (2-5)

36. What can sometimes complicate treatment of a bacterial infection when an antibiotic is used? (2-7)

37. List six secondary factors involved in the development of a disease. (2-8)

38. Which sex, male or female, is more likely to transmit leptospirosis more readily between canines and why is this so? (2-9)

39. State three conditions of animals that make some more susceptible to disease than others. (2-10-12)

40. How does the size of a susceptible population affect the transfer of disease organisms? (2-15)

41. What are the three basic procedures for controlling disease? (2-17)

42. In reference to controlling disease, how do we increase the resistance of the host? (2-19)

43. Name three zoonotic diseases. (2-20)

44. How is rabies virus normally introduced into the human body? (2-21)

45. In what phase of rabies do the first symptoms occur? (2-23)

46. After the first phase of rabies, what are the two possible forms of the disease called? (2-23)

47. List the symptoms of the dumb form of rabies. (2-25)

48. Can man be infected with rabies by a dog in the dumb stage of the disease? (2-25)

49. What are the three techniques normally used by the laboratory in diagnosis of rabies? (2-26-27)

50. Why should rabies suspects be confined and the disease allowed to progress? (2-27)

51. What is the period of quarantine for an animal suspected of having rabies? (2-28)

52. What type of microorganism causes leptospirosis? (2-30)

53. Why should animals with leptospirosis be confined or kept away from other animals even after recovery from the disease? (2-32)

54. What is the cause of the disease commonly known as ringworm? (2-33)

55. What are two methods of diagnosing ringworm? (2-35)

56. What disease is the "scourge of dogdom"? (2-38)

57. What is the incubation period of distemper? (2-40)

58. What type of microorganism is responsible for causing infectious canine hepatitis? (2-42)

59. With what other disease are the early symptoms of infectious canine hepatitis often confused? (2-42)

60. What condition may result in a dog which is recovering from infectious canine hepatitis? (2-44)

61. In addition to all members of the cat family, what animal is susceptible to feline distemper? (2-45)

62. What are the symptoms of feline pneumonitis? (2-48)

63. What is the best protection for a cat against feline pneumonitis? (2-50)

64. What produces inflammation of the skin (dermatitis)? (2-52)

65. Describe conjunctivitis. (2-54)

66. What are some possible causes of conjunctivitis? (2-55)

67. What is otitis and what symptoms would a dog having it display? (2-56, 57)

68. What is the most common cause of gingivitis? (2-59)

69. What are the symptoms of gingivitis? (2-60)

70. How can gastroenteritis (inflammation of the stomach or intestine) be detected? (2-63)

71. What are the two general types or classifications of parasites? (2-65)

72. How is a definite diagnosis of parasitic diseases made? (2-67)

73. How does a dog contract or become infected with hookworms? (2-68)

74. What endoparasites are zoonotic and what diseases do they cause in humans? (2-68-70)

75. If a person were to request information for preventing transmission of tapeworms to his small toy poodle, which is a house pet, what should you tell him? (2-74, 75)

76. What are the first signs of infection of an animal with heartworms? (2-76)

77. What are the four stages in the life cycle of the heartworm? (2-77)

78. How can you detect the presence of microfilariae? (2-79)

79. What are the three stages of development in the tick? (2-82)

80. What treatment would be necessary to completely rid an animal of fleas? (2-85, 87)

81. What is the first step in treating infestations by fleas? (2-87)

82. How are most lice transmitted from one host to another? (2-90)

83. What are the names of the two types of mites that cause skin disease in small animals? (2-91)

84. Normally, how is an inflammation of the skin determined to be mange? (2-92)

85. Describe the characterisitcs of an ear mite infection. (2-93)

86. How are ear mites diagnosed? (2-94)

MODIFICATIONS

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CHAPTER 3

Objective: To be able to determine the wholesomeness and condition of fruits and vegetables by applying basic facts concerning plant life and its breakdown, product procurement, certification and shipment, and the control of product storage environment during inspections.

1. **What is photosynthesis? (6-2)**

2. **What is transpiration? (6-3)**

3. **What is respiration? (6-4)**

4. When is a fruit mature? (6-5)

5. Describe "ripeness." (6-6)

6. What are three types of heat that affect the shipping, storage, and distribution of fruits and vegetables? (7-2) (7-2)

7. What are two methods of removing field heat? (7-3)

8. What are some ways to decrease vital heat in fruits and vegetables? (7-4)

9. What is "container" heat? (7-5)

10. What two temperatures will satisfy the storage requirements of most fruits and vegetables? (7-7)

11. What situation will cause shriveling of fruits and vegetables? (7-7)

12. What environmental factor is closely related to humidity? (7-9)

13. Is there one relative humidity that is optimum for the storage of all fresh fruits and vegetables? Explain. (7-11)

14. Briefly describe controlled atmosphere (CA). (7-13)

15. Describe condition factors. (8-1)

16. Describe quality factors. (8-1)

17. Describe "grade." (8-1)

18. What are the two categories of condition factors? (8-2)

19. What is an example of a biological condition factor? (8-3)

20. What is the most commonly encountered physical condition factor? (8-7)

21. What action can you take if you feel that there are enough quality defects to cause you to question the grade of a shipment of fresh fruits and vegetables? (8-11)

22. What is the highest grade a fresh fruit or vegetable can receive? (8-14)

23. What information could be found in the specification for a particular produce item? (8-16)

24. For what information would you read a US Standard? (8-17)

25. What is the purpose of DPSC Articles and Clauses? (8-18)

26. What is the purpose of a "purchase description" found in a contract? (8-19)

27. What are two ways the government can purchase fresh fruits and vegetables? (8-20)

28. What is the main difference between street and field buying? (8-21)

29. What items are listed in the Subsistence Master Solicitation? (8-24)

30. What agency issues an inspection certificate indicating the product complies with contract requirements for grade? (8-28)

31. When may a vendor inspect his own produce for grade? (8-28)

32. Generally, who performs the class 3 inspection on produce procured by the military? (8-31)

33. What should you do if during a class 4 inspection of produce (DPSC contract) you find that the products do not match those on the inspection certificate? (8-33)

34. Who do you notify if you want to recommend rejection of a shipment of produce on a class 8 inspection? (8-38)

35. What is your main concern during a class 6 inspection of produce? (8-40)

36. A shipment of Government-owned produce arrives at your base from a DPSC warehouse. What class of inspection do you perform? (8-43)

37. When would you perform a class 9 inspection on produce at the cold storage facility? (8-44)

38. What is the purpose of a class 7 inspection? (8-46)

39. What are the "top ten" produce items purchased by the military? (8-48)

40. On apples, what defect is characterized by diffuse browning and killing of the skin? (8-50)

41. What defect of grapefruit is characterized by a brownish decay accompanied by a penetrating, rancid odor? (8-52)

42. Why shouldn't you use the color of an orange as a guide to maturity? (8-54)

43. What are two common types of injury common to grapes? (8-57)

44. How are bananas ripened? (8-58)

45. Describe the injury caused by chilling bananas. (8-60)

46. If tomatoes are to be shipped any distance, at what stage of maturity and ripeness should they be picked? (8-61)

47. Celery that has dry, limp stalks has probably been subjected to what type of injury? (8-64)

48. Describe the characteristics of desirable head lettuce. (8-66)

49. How can you best detect internal rot in onions? (8-68)

50. What happens to potatoes that are stored in light? (8-69)

51. Describe the desirable characteristics of high quality potatoes. (8-70)

CHAPTER 4

Objective: To show knowledge of how to relate the biological characteristics of waterfoods to the problems of handling, processing, and inspecting the products.

1. What is the first step in inspecting waterfood products? (9-1)

2. If you must use color as a last resort in identifying species of fish, which colors can be used with a fair degree of safety because they do not fade rapidly? (9-3)

3. What are three changes that all animal flesh goes through after death? (9-5)

4. Why is rigor mortis a desirable characteristic of fish? (9-7)

5. How does the method of catch affect rigor mortis in waterfoods? (9-8)

6. What is autolysis? (9-10)

7. When does autolysis begin in a fish? (9-10)

8. When inspecting fish, you note that the appearance is vey dull and the flesh is withered. What state of freshness do these characteristics indicate? (9-11; Table 1)

9. What organoleptic characteristics indicate rancidity in fish? (9-12)

10. What portion of a fish is affected by oxidative changes? (9-12)

11. What disease in humans is caused by consuming "copepods" (perch parasites) which burrow into the flesh and live off the host's tissue juices? (9-13)

12. How are most parasites detected in fish fillets? (9-14)

13. Under what circumstances does the military allow frozen fish to be thawed and then refrozen prior to purchase? (9-16)

14. What is Form III fish? (9-17)

15. List the three ways fillets of fish are generally marketed. (9-18)

16. What purpose does washing fish fillets in a brine solution serve? (9-19)

17. What parts of a fish are removed during the steaking process? (9-21, 22)

18. What are the advantages of fish portions? (9-25)

19. Are canned fish prepared fresh or frozen? (9-26)

20. Why is oil added to canned fish? (9-29)

21. What is the best method that you can use for inspecting fish processing? (9-31)

22. What is the tolerance allowed for parasites in cod and haddock? (9-35)

23. What is the maximum safe storage life for frozen fish? (9-38)

24. What is the purpose of holding canned fish samples until they reach room temperature? (9-41)

25. What conditions of the flesh and skin of canned fish detract from the overall appearance? (9-43)

26. What should you do after you check the appearance of the fish? (9-44)

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27. What is the easiest method of determining whether or not fish have been thoroughly cured? (9-46)

28. What is the purpose of preaward inspection and how does this obligate the Government? (9-47)

29. What obligation is put upon a vendor after a preaward inspection is performed? (9-48)

30. What inspection procedures are to be followed during a preaward inspection? (9-49)

31. List the principal shellfish that contain a poison responsible for paralytic shellfish poisoning? (10-2)

32. Why are shellfish that are harvested from "red tide" areas of public health significance? (10-3)

33. What common seafoods are classified as mollusks? (10-4)

34. Why are scallops less likely to be contaminated by pollution than clams and oysters? (10-5)

35. How do scallops differ from other mollusks? (10-5)

36. Why must scallops be processed immediately after harvesting? (10-6)

37. What indication do you look for to detect spoilage or staleness in a bag of fresh scallops? (10-8)

38. What condition indicates rancidity in frozen scallops? (10-9)

39. Why are soft-shell clams stored in live boxes or floats after being caught? (10-11)

40. What is the purpose of steaming fresh clams for canning? (10-15)

41. What effect does a water temperature below 50°F. have on fresh clams? (10-17)

42. What causes clams to become the color of tomato sauce? (10-17)

43. What is the "bad" period of oyster condition? (10-19)

44. What does the term "floating" mean in relation to oysters? (10-20)

45. Why is the amount of exposure to water so important during oyster processing? (10-21)

46. What is "drinking" or "soaking" with regard to oyster processing? (10-21)

47. If you receive a shipment of Type II, Class I, Size (d) oysters, how many would you expect to find per 6 pounds? (10-23; Table 2)

48. List seven conditions of oysters that make them rejectable besides being floaters or gapers. (10-26)

49. During a class 4 inspection of oysters, you find many small parasitical crabs on them; is the presence of these crabs reason for rejection of the oysters? (10-27)

50. What factor is most reliable in determining the freshness of oysters, and how is it detected? (10-27)

51. List the crustaceans most widley consumed. (10-28)

52. If shrimp are to be kept at sea for a period of time, how are they processed? (10-29)

53. What are the common names of the three species of shrimp representing the greater part of the harvest? (10-30)

54. How can you distinguish a pink shrimp from a brown shrimp? (10-33)

55. What undesirable conditions can occur in shrimp that are not processed and chilled immediately after harvesting? (10-36)

56. When inspecting fresh shrimp, what factors can you use in determining if they are in prime condition? (10-37)

57. What is a good indication of shrimp freshness? (10-37)

58. How are shrimp sized? (10-39)

59. What documents will specify the tolerance for undersize shrimp? (10-39)

60. What is the lowest numerical grade allowable for a military contract on shrimp? (10-41)

61. What is the purpose of inverting packaged shrimp during the glazing operation after the open packages pass under a spray? (10-43)

62. Where will you find detailed quality requirements for breaded shrimp? (10-46)

63. What does "range" refer to in breaded shrimp? (10-46)

64. Why are soft-shell crabs not normally used for canning? (10-47)

65. Why are crabs difficult to bleed prior to processing? (10-48)

66. Which species of crab must be processed prior to shipment and why is this so? (10-52)

67. Which species of crab is the most suitable for freezing? (10-53)

68. While inspecting canned crabmeat you find small orange-yellow globules and small quantities of a light yellow substance in the can. What must you do? (10-55)

69. Differentiate between the spiny lobster and the northern lobster. (10-56)

70. Of the two types of lobsters, which one is often handled like shrimp and processed rather than sold live? (10-58)

71. Why is lobster meat dipped in brine that contains a small amount of citric acid prior to canning? (10-59)

CHAPTER 5

Objective: To demonstrate a knowledge of the microorganisms associated with dairy products and the analyses of dairy products for quality and wholesomeness.

1. How can proper quality controls on dairy products be insured? (11-1)

2. What publications list the requirements for dairy products set down by the military? (11-1)

3. Who at base level prepares contracts for dairy products? (11-2)

4. What makes up a Purchase Instrument? (11-3)

5. What publication contains the instructions for procurement quality assurance? (11-4)

6. What is found in AFM 74-15, *Procurement Quality Assurance*, Appendix A, *Fresh Dairy Products*? (11-4)

7. What are the three inspector positions involved in Procurement Quality Assurance? (11-5)

8. Who is responsible for the administration of Procurement Quality Assurance?(11-6)

9. Who assures that the contractor has provided accurate tare weights and production codes? (11-6)

10. What are the general duties of the Origin Inspector? (11-7)

11. What is the primary function of the Destination Inspector? (11-8)

12. What determines if the frequency of sampling dairy products will increase or decrease? (11-8)

13. How do you determine if milk is of sufficient quality to stay fresh for the length of the shelf life? (11-8)

14. How long do you keep milk (for a keeping quality test) at a temperature of 40°F.? (11-8)

15. What purpose does the contractor's quality history file serve? (11-9)

16. What causes the deteriorative changes that take place in fresh dairy products? (12-1)

17. Name four microorganisms of concern to us with regard to dairy products. (12-2)

18. What three groups of bacteria comprise the lactic acid producers? (12-3)

19. What type of bacteria are used as starters in making cultured buttermilk? (12-4)

20. What type of bacteria will you usually find in aseptically drawn milk? (12-5)

21. What is the importance of lactobacilli? (12-6)

22. What is a common source of spore-forming bacilli in dairy products? (12-7)

23. What bacteria do you expect to find in raw milk, so much so that its absence causes you to suspect inhibitors were added? (12-8)

24. What is indicated by the presence of large numbers of coliform bacteria in milk? (12-8)

25. When are coliform organisms normally destroyed? (12-9)

26. To what temperature must milk be cooled if it is not to be delivered to the plant within 2 hours? (12-10)

27. What microorganism in milk can tolerate rather high acidity? (12-11)

28. How do yeasts affect dairy products? (12-11)

29. What causes fish eyes in cheese? (12-11)

30. Name the general properties of milk with which you should be familiar. (13-2)

31. What is the normal color of milk? (3-3)

32. Why should an inspector test the odor of raw milk and not the taste? (13-4)

33. With what instrument do we test the specific gravity of milk? (13-5)

34. What are we attempting to detect when we measure the specific gravity of milk? (13-5)

35. Why are laboratory tests performed on fresh dairy products? (13-6)

36. What is the purpose of the SPC test? (13-7)

37. Where do you find the tolerance for the bacterial count of a dairy product? (13-7)

38. What does a high SPC level generally indicate? (13-8)

39. What are the two most important coliform organisms with regard to dairy products? (13-9)

40. What is the source of *E. coli*? (13-9)

41. What is the source of *Aerobacter aerogenes*? (13-9)

42. What two types of agar are used to perform the coliform test? (13-10)

43. What type of agar used in the coliform test must not be autoclaved? (13-10)

44. What type of agar demonstrates *E. coli*? (13-10)

45. What does *E. coli* look like when growing on eosin methylene blue agar? (13-10)

46. For what purpose is the Babcock test used? (13-11)

47. What makes up the total solids of milk? (13-12)

48. Where would you find the requirements for percent butterfat, solids-not-fat, or total solids in a dairy product? (13-12)

ANSWERS FOR CHAPTER REVIEW EXERCISES

CHAPTER 1

1. *a.* To prevent pets from becoming health hazards.
   b. To prevent animal population control problems in the community.

2. *a.* Immunizations.
   b. Parasite treatment.
   c. Bacterial and fungal infection treatment.

3. By neutering pets.

4. From either a commercial source or base medical supply using nonappropriated funds.

5. Nonappropriated.

6. The Base Commander.

7. The Base Commander.

8. He must present proper identification.

9. Advise the caller to bring his pet to the clinic for examination.

10. To record all clinical treatments and immunizations of pets.

11. Only veterinary service personnel.

12. AFR 163-4, *Prevention and Control of Communicable Diseases of Animals.*

13. DD Form 793 and AF Form 1554.

14. When a new certificate is made or the animal dies or departs the station.

15. Watch all animals closely.

16. To prevent emotional stress in the pets' owners.

17. Clean the area immediately.

18. It is a normal reaction of an excited animal.

19. Be sure to practice adequate sterilization and disinfection procedures.

20. By autoclaving.

21. Residual sterilization chemicals may kill the virus in live virus vaccines.

22. They should be melted, shredded, or sufficiently mutilated to prevent reuse.

23. They are accountable to CBF.

24. *a.* Order the item and use it immediately.
b. Maintain a running balance of each controlled item on AF Form 579.
c. Maintain an AF Form 582 on each item ordered from commercial sources.

25. *a.* Make an AF Form 582 for each item.
b. Prepare a prescription for each use and make appropriate entries on the AF Form 582.
c. Maintain the prescription for 3 years with the AF Form 582.
d. Destroy the AF Form 582 3 years after the last entry disposing of the product.

26. *a.* Microscopic examination of feces.
b. Ear swabbing.
c. Skin scraping.
d. Blood sample examination.

27. When an animal bite incident is reported.

28. It is filed in the patient's medical records.

29. The local civilian quarantine authorities.

30. *a.* When the animal is involved in a bite incident.
b. When the animal is transported from one state, or country, to another

31. To secure information on rules for quarantine rules, etc.

32. A study of all the factors that influence the occurrence of diseases in a community.

33. *a.* Scalding.
b. Freezing.
c. Ionizing radiation.

34. Through immunity.

35. *a.* Eye.
b. Skin.
c. Respiratory tract.
d. Digestive tract.
e. Reproductive tract.

36. Antiobiotic strains of organisms sometimes develop.

37. *a.* Sex.
b. Age.
c. Nutritional status.
d. Housing.
e. Climate.
f. Trauma.

38. Male; widespread urination and a tendency to smell or lick areas on which other dogs have urinated.

39. *a.* Youth.
    b. State of health.
    c. Housing conditions.

40. Transfer of the organism is enhanced.

41. *a.* Prevent or reduce contact with infected animals.
    b. Increase the resistance of the host.
    c. Treat the infected host.

42. Vaccinate the animal.

43. *a.* Rabies.
    b. Leptospirosis.
    c. Ringworm.

44. Through an animal bite or scratch.

45. Prodromal (beginning).

46. *a.* Furious.
    b. Dumb (paralytic).

47. The animal is sluggish and morose.

48. Yes. Through infectious saliva entering a cut or scratch while examining the dog.

49. *a.* Examine the brain tissue for Negri bodies.
    b. Demonstrate fluorescent bodies.
    c. Inoculate mice with a suspension of the brain tissue.

50. To insure accuracy of the lab tests.

51. Ten days.

52. A bacteria.

53. The animal continues to shed the organism for some time after recovery.

54. A fungus.

55. *a.* Microscopic examination of hair or lesion scraping.
    b. Culture the scraping.
    c. Demonstrate fluorescence of the lesion.

56. Canine distemper.

57. 6 to 9 days.

58. A virus.

59. Distemper.

60. Transient opacity of the cornea of the eye.

61. The raccoon.

62. *a.* Sneezing.
    b. Mucous membrane inflammation of the nose.
    c. Secretion of tears.
    d. Eye membrane inflammation.
    e. Fever.

63. *a.* Avoid exposure to sick animals.
    b. Don't overcrowd.
    c. Prevent stress.

64. External irritations.

65. Inflammation of the lining of the eyelid.

66. *a.* Bacteria.
    b. Viruses.
    c. Foreign material.
    d. Chemical agents.

67. Inflammation of the skin within the ear canal; restlessness, scratching or rubbing, and head shaking or inclining the head.

68. Accumulation of calculus deposits on the necks of the teeth.

69. Swollen, ulcerated, and bleeding gums.

70. Vomiting and diarrhea are general symptoms.

71. Endoparasites and ectoparasites.

72. By identifying the parasite or its eggs.

73. *a.* Ingestion of larvae.
    b. Skin penetration by the larvae.
    c. Prenatal infection by larvae.

74. *a.* Dog hookworms; cutaneous larva migrans (ground itch).
    b. Roundworms; visceral larva migrans.

75. *a.* Feed him only prepared food.
    b. Keep him "flea-free."

76. A chronic cough or rapid tiring.

77. *a.* Egg.
    b. Microfilaria.
    c. Larva.
    d. Adult.

78. Only with a microscopic examination of a blood sample.

79. *a.* Larva (seed tick).
    b. Nymph.
    c. Adult.

80. *a.* Give an oral or topical preparation to the animal.
    b. Deflea the animal's environment.

81. Discovery and identification.

82. By direct contact.

83. *a.* Sarcoptes.
    b. Demodectes.

84. By microscopic examination of the mites.

85. Irritation of the ears and a tarlike substance with a foul odor.

86. Through microscopic examination of ear swabbings.

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CHAPTER 3

1. The means by which plants, with the use of sunlight, manufacture oxygen and simple sugars.
2. The process by which excess water is given off from a plant.
3. The process by which plants break down stored compounds to liberate energy.
4. When growth stops and the seeds are fully developed.
5. When enough starches have been converted into sugars to make the product fit for use.
6. Field, vital, and container heat.
7. Hydrocooling and vacuum cooling.
8. Refrigeration, waxing, wrapping, and harvesting at a less advanced stage of maturity.
9. Heat acquired from the actual container material, from the warehouse and transport vehicle, and from the surrounding atmosphere.
10. 32°F. or 45°F.
11. Fluctuating temperatures.
12. Temperature.
13. No. The relative humidity should be close to the moisture content of the item being stored.
14. It is a process of replacing the oxygen with inert gas.
15. Such factors as decay, disease, and internal unseen factors inherent to that particular product.

16. The categories are appearance, texture, and flavor.

17. The sum of the characteristics at the time the item is graded, including both quality and condition factors.

18. Biological and physical.

19. Decay or insect damage.

20. Mechanical injury.

21. Request a formal review or a grade reinspection.

22. US Fancy (or Extra Fancy).

23. A detailed description of the specific requirements for the product.

24. The possible grades for that item, the tolerance for undergrade items, and definitions of terms used to describe grading factors.

25. Supplementary information on such topics as inspection procedures, inspection certificates, and delivery requirements.

26. Describes qualifying factors that are unique or which are higher than those incorporated in the grade specification.

27. Street buying and field buying.

28. In street buying, the procurement agent visits a terminal or local market. In field buying, the agent visits the growing area or packing facility.

29. Items to be purchased, quantities, specifications, delivery dates, closing time, and applicable clauses.

30. The USDA.

31. When the value of the produce does not justify the expense of a USDA inspection.

32. The USDA.

33. Halt the inspection and notify your NCOIC or your OIC, who will in turn notify the Quality Assurance Office, Subsistence Regional Headquarters of DPSC (QAO-SRH-DPSC).

34. Notify the personnel at the receiving activity and inform the carrier of the reason why the product is not acceptable.

35. To advise the accountable property officer as to the the compliance or noncompliance of the carrier with requirements for temperature and loading, etc., and as to the suitability of the product for its intended use.

36. Class 5.

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37. If it remained in storage for over 90 days.

38. To insure that no contaminated, decomposed, or otherwise unwholesome food is issued or offered for sale.

39. Potatoes, bananas, apples, oranges, lettuce, tomatoes, grapes, grapefruit, onions, and celery.

40. Scald.

41. Brown rot.

42. Many oranges have color added.

43. Mechanical and freezing injury.

44. Domestically, in a controlled atmosphere of ethylene gas.

45. Dull colored skin which is sometimes brown.

46. Fully mature, but not yet red in color.

47. Freezing.

48. It should be tender, well-trimmed, and firm, without an excessive amount of outer leaves.

49. By feeling them.

50. They turn green.

51. They are firm, relatively smooth, clean, and reasonably well-shaped. They are not badly cut, bruised, wilted, sprouted, sunburned, or lightburned.

CHAPTER 4

1. Confirm the identity of the product.

2. Black and brown pigmentation.

3. Rigor mortis, autolysis, and putrefaction.

4. The bactericidal effect prolongs storage life.

5. Fish allowed to panic and struggle enter rigor mortis very soon after death and have a relatively short storage life.

6. The disintegration of cells by action of their own enzymes.

7. Immediately after death.

8. Putrid fish.

9. A bitter flavor which leaves a tallowy, soapy taste, and a strong pungent odor.

10. Fat content.

11. None.

12. By candling the fillets.

13. When frozen fish are to be processed in the cannery.

14. Fillets, single or butterfly.

15. Skin on, skinless, and butterfly.

16. Minimizes drip formation when the frozen fish thaws and gives the fish a better flavor.

17. Dorsal and ventral fins, some gristle at the nape, the nape, and the belly.

18. Uniformity in size and reduction in waste.

19. Either fresh or frozen.

20. It replaces strong fish oil and prevents scorching.

21. Observe all parts of the processing.

22. No more than 2 parasites per 100 fillets.

23. Six months.

24. Allows oil to rise to top, causing abnormal odors to be readily detected.

25. Honeycombing, watermarking, or pew marks.

26. Smell and taste.

27. To cut into the thickest part of the flesh.

28. Allows the vendor to stockpile seafoods during the flush season for purchase by the Armed Forces in the off season but does not obligate the Government at all.

29. No obligation at all.

30. The same as if the product was being bought at that time.

31. Clams, mussels, and scallops.

32. Because of the presence of small planktonic marine organisms (Gongaulax catemella) which cause paralytic shellfish poisoning.

33. Scallops, clams, and oysters.

34. Because of their mobility they are found in deeper waters.

35. They retain their mobility throughout their life.

36. Since they do not retain entrapped water, they will die soon after netting.

37. A characteristic "gassy" odor.

38. A yellowish tinge in color.

39. The clams purge themselves of sand and mud and are then of better quality.

40. To open the shell.

41. They will have a brownish-orange tint around the digestive tract when first opened.

42. Shucked clams which have stood for several days may turn the color of tomato sauce.

43. The traditional "bad" periods reflect the oyster's condition following spawning.

44. Holding market-size oysters on flats in shallow water near shore, which causes them to take on water and bloat.

45. If held in contact with fresh water for a long period, they will lose much of their soluble flavoring properties and will absorb considerable quantities of water.

46. When oysters are held in fresh water for a long period of time, they will absorb considerable quantities of water.

47. 149 to 212 meats per 6 pounds.

48. Spawny, undernourished, sour, bloated, pink, elongated, and green-gilled.

49. No, they are a delicacy themselves.

50. The pH is the most reliable factor. It is determined by using a Taylor Slide Comparator or any other pH meter.

51. Shrimp, crab, and lobster.

52. They are beheaded, and the meaty tails are placed in cold storage.

53. White, brown, and pink.

54. Pink shrimp have a red or brown spot on each side at about the middle of the tail.

55. Bacterial and autolytic spoilage and black spot.

56. Firmness and odor.

57. Odor.

58. By count per pound.

59. The purchase documents, including specifications or purchase description, DPSC clauses, and purchase orders.

60. 80.

61. Allows the free water in the package to freeze on the top of the package, thus forming a covering of ice on both the top and bottom of the pack.

62. In the purchase description for breaded shrimp.

63. The amount of breading allowed on the shrimp.

64. They tend to be watery and poor in texture after canning.

65. The blood perfuses the tissue rather than being confined in the vessels.

66. The king crab. There is a great distance between the fishing grounds and the canneries.

67. The king crab.

68. Distinguish both eggs and fat from the entrails. The eggs and fat are perfectly wholesome and acceptable.

69. The northern lobster has large crushing claws, while the spiny lobster has long spiny feelers.

70. The spiny lobster.

71. To keep it from blackening in the can.

CHAPTER 5

1. By instituting a thorough inspection system which begins on the form and continues through all aspects of dairy products production.

2. The *Grade "A" Pasteurized Milk Ordinance* and AFM 74-15, *Procurement Quality Assurance,* Appendix A, *Fresh Dairy Products.*

3. The purchasing and contracting officer.

4. A contract and the referenced documents.

5. Appendix A of AFM 74-15.

6. It contains concepts and policies as well as prescribed procedures and techniques to perform uniform procurement quality assurance.

7. Administrative control inspector (ACI), origin inspector, and destination inspector.

8. The administrative control inspector (ACI).

9. The administrative control inspector (ACI).

10. (a) Provides data to the ACI in the contractor's quality control.
    (b) Coordinates any necessary changes that the ACI has arranged in the sampling plan.
    (c) Assists the ACI with any problems related to accurate tare weights and production codes at the plant.

11. To supply the ACI with current, reliable data on the contractor's quality control.

12. The contractor's quality history file.

13. Perform a keeping quality test.

14. Seven days.

15. The frequency of examinations and sample collection and submittals are based on the contractor's quality history file.

16. Microorganisms.

17. (a) Lactic-acid-producing bacteria.
    (b) Spore-forming bacilli.
    (c) Coliform bacteria.
    (d) Yeasts.

18. (a) Streptococci.
    (b) Staphylococci.
    (c) Lactobacilli.

19. Streptococci.

20. Staphylococci.

21. They are used in the production of certain cheeses.

22. Soil.

23. Coliform bacteria.

24. Poor or faulty sanitation in both raw and pasteurized milk.

25. During pasteurization.

26. 50° F.

27. Yeasts.

28. (a) They cause gassiness in sweetned condensed milk.
    (b) Yeastiness is common in old cream and often carries over to butter when it is used in its manufacture.
    (c) They cause a yeasty flavor in cheese.

29. Yeasts.

30. Its color, flavor, odor, and specific gravity.

31. It varies from light cream to light bluish-white.

32. Tasting raw milk subjects the inspector to a variety of milkbone diseases.

33. A lactometer.

34. Milk that has been grossly adulterated with water.

35. To determine quality, wholesomeness, and contract compliance.

36. To determine the number of bacteria in a food sample.

37. The applicable specification.

38. Low quality.

39. *E. coli* and *Aerobacter aerogenes.*

40. The GI tract of animals and man.

41. Dust and soil.

42. Eosin methylene blue and desoxycholate.

43. Desoxycholate.

44. Eosin methylene blue.

45. A green sheen.

46. To determine the butterfat content of dairy products.

47. Butterfat and solids-not-fat.

48. The applicable specifications.

STOP– **1. MATCH ANSWER SHEET TO THIS EXERCISE NUMBER.** 2. USE NUMBER 1 OR NUMBER 2 PENCIL.

90850 04 23

VOLUME REVIEW EXERCISE

Carefully read the following:

DO'S:

1. Check the "course," "volume," and "form" numbers from the answer sheet address tab against the "VRE answer sheet identification number" in the righthand column of the shipping list. If numbers do not match, take action to return the answer sheet and the shipping list to ECI immediately with a note of explanation.
2. Note that numerical sequence on answer sheet alternates across from column to column.
3. Use a medium sharp #1 or #2 black lead pencil for marking answer sheet.
4. Circle the correct answer in this test booklet. After you are sure of your answers, transfer them to the answer sheet. If you *have* to change an answer on the answer sheet, be sure that the erasure is complete. Use a clean eraser. But try to avoid any erasure on the answer sheet if at all possible.
5. Take action to return entire answer sheet to ECI.
6. Keep Volume Review Exercise booklet for review and reference.
7. If *mandatorily* enrolled student, process questions or comments through your unit trainer or OJT supervisor.
   If *voluntarily* enrolled student, send questions or comments to ECI on ECI Form 17.

DON'TS:

1. Don't use answer sheets other than one furnished specifically for each review exercise.
2. Don't mark on the answer sheet except to fill in marking blocks. Double marks or excessive markings which overflow marking blocks will register as errors.
3. Don't fold, spindle, staple, tape, or mutilate the answer sheet.
4. Don't use ink or any marking other than a #1 or #2 black lead pencil.

NOTE: TEXT PAGE REFERENCES ARE USED ON THE VOLUME REVIEW EXERCISE. In parenthesis after each item number on the VRE is the *Text Page Number* where the answer to that item can be located. When answering the items on the VRE, refer to the *Text Pages* indicated by these *Numbers*. The VRE results will be sent to you on a postcard which will list the *actual VRE items you missed*. Go to the VRE booklet and locate the *Text Page Numbers* for the items missed. Go to the text and carefully review the areas covered by these references. Review the entire VRE again before you take the closed-book Course Examination.

8. (011) DD Form 1744, Veterinary Health Certificate, is initiated

a. only for patrol dogs.
b. on completion of the quarantine of a rabies suspect.
c. on animals to be transported to another state or country.
d. in none of the above instances.

9. (011) The most accurate information concerning shipment of pets to a foreign country may be obtained from the

a. local airline.
b. base veterinarian.
c. base transportation office.
d. destination country's embassy in Washington, DC.

10. (012) A secondary factor involved in the development of a disease is

a. age.
b. speed.
c. bacteria.
d. antibiotics.

11. (012) Select a good example of a vector.

a. A fomite.
b. An arthropod.
c. Bacteria.
d. A contaminated pond.

12. (012) Man can contract a zoonotic disease through

a. arthropod vectors.
b. contacting diseased tissues during slaughter.
c. eating improperly cooked tissues of infected animals.
d. all of the above.

13. (013) The prodromal stage of rabies is characterized by

a. fearlessness and gauntness.
b. sluggishness and moroseness.
c. furiousness and viciousness.
d. nervousness and excitability.

14. (013) What is the quarantine period for a rabies suspect?

a. 7 days.
b. 14 days.
c. 10 days.
d. 30 days.

15. (014) Ringworm can sometimes be diagnosed by

a. exposure to ultraviolet light.
b. microscopic examination of the feces.
c. microscopic examination of the blood.
d. none of the above.

16. (014) Canine distemper is caused by a

a. virus.
b. bacteria.
c. rickettsia.
d. mold.

17. (014) Mucous discharge from the nose and eyes, coughing, and convulsions or "fits" are symptoms of

a. rabies.
b. distemper.
c. leptospirosis.
d. hepatitis.

18. (015) Twenty-five percent of those dogs recovering from infectious canine hepatitis may be expected to

a. suddenly die for no apparent reason.
b. be permanent carriers of the disease.
c. have convulsive seizures known as chorea.
d. develop transient opacity of the cornea of one or both eyes.

19. (015) Which statement is *not* true concerning feline distemper?

a. It is highly contagious.
b. It is caused by bacteria.
c. Sixty to 90 percent of infected cats die.
d. It is characterized by general illness and fever.

20. (015) Feline pneumonitis is best characterized as a

a. parasitic disease.
b. respiratory infection.
c. disease of the GI tract.
d. nervous disease.

21. (016) An inflammation of the inner covering of the eyelid is called

a. cystitis.
b. dermatitis.
c. gingivitis.
d. conjunctivitis.

22. (016) An animal which exhibits restlessness, which may scratch or rub its ears, and which may shake its head or incline it to one side probably suffers from

a. fleas.
b. otitis.
c. gingivitis.
d. pneumonitis.

23. (017) Bloody vomitus, abdominal pain, and exceptionally foul-smelling feces are often indications of

a. gingivitis.
b. heartworms.
c. conjunctivitis.
d. gastroenteritis.

24. (017) Infection by penetration of the skin by larvae occurs with

a. roundworm.
b. tapeworm.
c. hookworm.
d. whipworm.

25. (018) Visceral larvae migrans is a condition of man caused by the larvae of the

a. roundworm.
b. hookworm.
b. tapeworm.
d. whipworm.

26. (018) An internal parasite that usually attaches to the wall of the cecum is the

a. tapeworm.
b. roundworm.
c. whipworm.
d. heartworm.

27. (018) The rabbit serves as the intermediate host for a type of

a. roundworm.
b. tapeworm.
c. heartworm.
d. whipworm.

28. (019) A dog infected with heartworms will likely exhibit which symptom?

a. Vomiting.
b. Diarrhea.
c. A bloody stool.
d. A chronic cough.

29. (019) The microfilaria is a stage in the life cycle of the

a. hookworm.
b. whipworm.
c. heartworm.
d. roundworm.

30. (020) The stages of development of a three-host tick are

a. egg, seed tick, and nymph.
b. adult, seed tick, and larva.
c. egg, larva, nymph, and adult.
d. larva, nymph, seed tick, and adult.

31. (021) How are lice normally transmitted?

a. By direct contact.
b. Through feces.
c. By airborne ova.
d. By an intermediate vector.

32. (022) Mange is caused by

a. mites.
b. fleas.
c. lice.
d. ascarides.

48. (044) Concerning the process of photosynthesis in green plants, which choice is correct?

a. Produces chlorophyll.
b. Produces simple sugars and oxygens.
c. Breaks down chlorophyll for energy.
d. A process by which sugars are broken down for energy.

49. (044) Transpiration is a process by which

a. plants produce chlorophyll.
b. plants get their energy.
c. excess water is given off by plants.
d. dead fruits and vegetables are broken down.

50. (044) Respiration is a physiological process of plants which

a. liberates stored energy.
b. ceases at the time of harvest.
c. cannot be controlled by heat.
d. results in carbohydrate production.

51. (044-045) Which choice is correct concerning maturity of fruits and vegetables?

a. Maturity is the same as ripeness.
b. Maturity reached when the starches are converted to sugars.
c. Maturity is reached when growth stops and the seeds are developed.
d. Maturity is usually reached after the item is harvested.

52. (045) Heat that is externally generated is called

a. field heat.
b. vital heat.
c. latent heat.
d. respiration heat.

53. (045) Which choice is correct concerning heat produced by respiration?

a. Called field heat.
b. Called vital heat.
c. Impossible to control.
d. The same amount for every type of fruit and vegetable.

54. (045) Which choice is correct concerning the fluctuation of fruit and vegetable storage temperature?

a. Results in extended storage life.
b. Has no effect on the condition of the products.
c. Is allowable if the fluctuation is less than 5° F.
d. May cause the items to shrivel and become unpalatable.

55. (046) In determining the required storage humidity, a good rule of thumb is to

a. have the humidity no higher than 50 percent, or items pick up moisture from the air and will increase in weight.
b. maintain a low humidity to retard the growth of microorganisms, thus preventing decay.
c. maintain humidity equal to or slightly above the normal moisture content of the product.
d. keep the humidity at 100 percent.

56. (046-047) Controlled atmosphere, CA, is

a. the same as relative humidity.
b. achieved by replacing the oxygen in the air with inert gasses.
c. achieved by regulating the temperature.
d. strictly a theoretical situation.

57. (047) Decay in fruits and vegetables is a factor

a. concerning quality.
b. which is *not* used in determining grade.
c. concerning condition.
d. which is not considered in determining condition.

58. (048) The physical condition factor most commonly encountered by veterinary inspectors is

a. heat injury.
b. freezing injury.
c. chemical damage.
d. mechanical injury.

59. (048) The grade reserved for fruits and vegetables that have high color and practically no defects is

a. US No. 1.
b. US Grade A.
c. US Extra Fancy.
d. US Choice.

60. (049) A directive that is published periodically to furnish additional information and terms for contracts is a

a. specification.
b. US Standard.
c. DPSC Article.
d. SMS.

61. (049) Your inspection responsibility on local purchase is *generally not* concerned with

a. condition.
b. grade.
c. net weight.
d. identity.

62. (049) The type of procurement in which the buyer visits a terminal or local market is called

a. market buying.
b. street buying.
c. SMS buying.
d. field buying.

63. (050) An item not listed on subsistence master solicitations is the

a. price.
b. quantity.
c. closing time.
d. specifications for the products.

64. (050) Generally, class 3 inspections of produce are accomplished by the

a. USPHS.
b. DPSC.
c. USDA.
d. USDI.

65. (051) During a class 4 inspection of DPSC purchased produce you find that the products don't match those on the USDA inspection certificate. You should

a. continue the inspection to see if the shipment complies with the contract.
b. ignore the missing certificate since the shipment has not been accepted yet.
c. halt the inspection and contact the veterinary NCOIC or OIC.
d. reject the load.

66. (051) If you find reason to recommend rejection of a product on a class 8 inspection, you should *first*

a. tell the driver to return the shipment to the supplier.
b. notify the personnel at the receiving facility.
c. notify the commissary officer.
d. notify DPSC.

67. (051) You are performing a class 6 inspection on a shipment of fresh fruits and vegetables. One of your main concerns is to determine

a. the acceptability of the product before final payment is made.
b. whether the warehouse and coolers are properly maintained.
c. the suitability of the product for its intended use.
d. the acceptability of the product prior to serving in dining halls.

68. (052) You are performing a class 5 inspection on a shipment of produce and you find that there is no USDA inspection certificate. What action should be taken?

a. Go ahead with your inspection-there should be no certificate on class 5.
b. Halt the inspection until the certificate is offered.
c. Notify DPSC.
d. Notify the commissary officer.

69. (052) Products on which a class 7 inspection is performed

a. are not yet Government owned.
b. will have just arrived from a DPSC warehouse.
c. will have been in cold storage for over 90 days.
d. are about to be issued to a dining hall or commissary.

70. (053) According to the text, which of the following condition factors are considered for grapefruit?

a. Brown rot.
b. Black rot.
c. Pithy.
d. Shoulder scar.

71. (053) Which choice is correct concerning the color of an orange?

a. Always bright orange when ripe.
b. Never greenish if they are of good quality.
c. Not a sure guide to quality.
d. Can never be "added."

72. (054) A banana bunch consists of

a. three to seven fingers.
b. five hands.
c. eight or more hands.
d. over 35 pounds of bananas.

73. (054) When inspecting celery, you find the stalks limp and dry. What is the probable cause?

a. Injured by heat.
b. Injured by freezing.
c. Harvested when overmature.
d. Stored for an extensive length of time.

74. (055) Which of the following is *not* a defect of lettuce?

a. Tip burn.
b. Hollow heart.
c. Water soft rot.
d. Bacterial soft rot.

75. (056) Identification of fish species that are beheaded, gutted, and frozen can often be determined by the

a. texture of the flesh.
b. inside covering of the body cavity
c. geographical area where they were caught.
d. position of the lateral line.

76. (056) Why is the color of fish used only as a last resort in determining the species?

a. Color patterns vary with processing techniques.
b. Colors often follow the same patterns between species.
c. Some inspectors may be color blind and mistake one species for another.
d. No color standards have been established and inspectors will have varied opinions.

77. (057) Which listed statement identifies the state of rigor mortis in a dead fish?

a. The fish will have a changed odor.
b. When pressure is removed, depression returns to its original state.
c. The fish is stiff and is hard to process.
d. When acidification sets in, the muscles relax.

78. (057-058) Which of the following will accelerate rigor mortis and reduce storage life of the fish?

a. Catching fish by handline.
b. Killing the fish immediately after boating.
c. Allowing fish to struggle before death.
d. Washing fish in cold water immediately after death.

79. (058) To be acceptable, the *maximum* number of parasites permissible for a single Pacific Ocean perch fillet is

a. 1.
b. 2.
c. 3.
d. 4.

80. (059) When fish to be canned are inspected, the state cannery inspector may grade them for condition by

a. the odor of the belly cavity.
b. the texture of the flesh.
c. overall appearance.
d. size and shape.

81. (059-060) Ideally, the first inspection should be performed while the fish is

a. alive.
b. whole.
c. freshly cut.
d. being packaged.

82. (060) Why must a class 3 inspector who is performing a cutout examination of canned fish hold the samples until their contents are near room temperature?

a. To allow the color to fix.
b. To assure that rigor mortis has ended.
c. To allow the produce to complete its cooking process.
d. To allow the oil to rise, permitting true odors to be released.

83. (061) A preaward inspection of fish products obligates the Government

a. in no way.
b. to purchase the fish at a later date.
c. to store the product until purchased.
d. to guarantee a minimum purchase price.

84. (062) A yellowish color in frozen scallops is an indication of

a. autolysis.
b. rancidity or oxidation.
c. delayed freezing.
d. too low a storage temperature.

85. (062) To improve the quality of clams gathered on tidal beaches, they are

a. thoroughly washed.
b. stored in live boxes or floats.
c. kept alive until ready to cook.
d. immediately iced and kept below 50° F.

86. (063) What happens to oysters if they are exposed to fresh water for a long period?

a. They become very soft and will fall apart.
b. They take on a greenish tint, making them less desirable.
c. They take on water, which increases their size and weight.
d. They will purge themselves of sand and mud, and are then of better quality.

87. (063) Which choice is correct concerning fresh oyster liquor?

a. It is of a translucent, milky color.
b. It is opaque and grayish in color.
c. It has gas bubbles on the surface.
d. It is acid, having a pH of 5.9 or lower.

88. (064) Which shrimp is softer in texture than other common shrimp, has a tail edged in green with the last tail segment edged in a dark color, and has the last tail segment keeled on top?

a. Pink shrimp.
b. Brown shrimp.
c. White shrimp.
d. Grooved shrimp.

89. (064) Which of the following is a very good indicator of fresh shrimp?

a. Odor.
b. Color.
c. Rigor mortis.
d. Adhesion of shell.

90. (065) In reference to US Standards for Shrimp, the grade is derived from

a. the size of the shrimp.
b. a comparison of the weight and the length of the shrimp.
c. an evaluation by an inspector using conformation, finish, and quality.
d. a numerical total value remaining after subtracting defect points from 100.

91. (067) Why are crabs cooked alive?

a. Soley to enhance the flavor.
b. To soften the shell.
c. Because we cannot bleed them, and they become inedible very rapidly otherwise.
d. Because otherwise the meat will tend to be watery and poor in texture.

92. (067) Which species of crab is most suitable for freezing and storage?

a. Blue.
b. King.
c. Dungenees.
d. Paper-shell.

93. (068) The most apparent difference between Northern and Spiny lobsters is that

a. the Northern lobster has huge front claws.
b. only the Spiny lobster has feelers.
c. only the Northern lobster has an exoskeleton.
d. only the Spiny lobster has an edible tail.

94. (068) In canning lobster meat, what purpose does citric acid serve?

a. It prevents discoloration.
b. It eliminates spoilage.
c. It helps form a vacuum.
d. It enhances the flavor.

95. (069) Dairy product contracts awarded at an Air Force installation are normally prepared by the

a. Base Commissary Officer.
b. Base Veterinarian.
c. accounting and finance officer.
d. purchasing and contracting officer.

96. (070) Which one of the following is *not* an established inspector position for procurement quality assurance?

a. Origin inspector.
b. Destination inspector.
c. Management control inspector.
d. Administrative control inspector.

97. (070) Determining whether any quality control problems were discovered at origin is a specific duty of the

a. plant manager.
b. destination inspector.
c. management control inspector.
d. administrative control inspector.

98. (070) The schedule for sampling dairy products at destination is arranged by the

a. Base Veterinarian.
b. administrative control inspector.
c. Commissary Officer.
d. destination inspector.

99. (71) The administrative control inspector uses the *contractor's quality history* file to determine

a. contract compliance of each shipment.
b. the frequency of examinations of dairy products.
c. whether the destination inspector is performing the required examinations.
d. the tolerance allowable bacteria counts in the products delivered to the base.

100. (071) A common thermoduric bacteria found in pasteurized milk is

a. *E. coli.*
b. *Aerobacter Aerogenes.*
c. staphylococcus.
d. streptococcus.

101. (072) An indication of poor or faulty sanitation in milk is the presence of large numbers of

a. molds.
b. coliform bacteria.
c. lactobacilli.
d. streptococci.

102. (072) If milk is *not* delivered to the processing plant within 2 hours, it must be cooled to at least

a. 35° F.
b. 40° F.
c. 50° F.
d. 55° F.

103. (073) An inspector should test raw milk for "off odor" instead of "off flavor" because

a. he should only judge the finished product.
b. the flavor of milk is not "set" in raw milk.
c. only an organoleptic examination should be performed on raw milk.
d. he should not expose himself to milk-borne diseases.

104. (073) An inspector, with aid of a lactometer, can measure the

a. specific gravity of milk.
b. butterfat content of milk.
c. lactose concentration in milk.
d. effectiveness of pasteurization of milk.

105. (073) The solids-not-fat and total solids in milk can be measured with the use of

a. a clarifier.
b. a lactometer.
c. the Babcock test.
d. the Quebec counter.

106. (073) Which of the following would be the least likely source of coliform contamination of pasteurized milk delivered to your base?

    a. Improperly covered containers.
    b. Improper sanitation of equipment.
    c. Fecal contamination occurring in the milking parlor.
    d. Hand contamination of product contact surfaces at the dairy.

107. (073) What two agars are used to perform the coliform test?

    a. Eosin methylene blue and tryptone glucose.
    b. Desoxycholate and peptone glucose.
    c. Tryptone glucose and desoxycholate.
    d. Eosin methylene blue and desoxycholate.

108. (073) *E. coli* colonies have a "green sheen" when cultured on

    a. desoxycholate agar.
    b. tryptone glucose agar.
    c. peptone glucose agar.
    d. eosin methylene blue agar.

109. (073-074) The Babcock test is used to determine the

    a. specific gravity of milk.
    b. butterfat content of dairy products.
    c. freezing point of milk.
    d. percentage of total solids of dairy products.

110. (074) Before you can properly interpret the results of Government laboratory tests for butterfat content of dairy products, you must *first*

    a. check the contract and applicable specification for stated requirements.
    b. determine the requirements from AFM 74-15, Appendix A.
    c. check the Government laboratory requirements for butterfat.
    d. determine the butterfat requirements from AFM 145-1, *Commissary Operating Manual.*

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CDC 90850

VETERINARY SERVICES SPECIALIST

(AFSC 90850)

Volume 5

Support of the Aerospace Medicine Program

Extension Course Institute

Air University

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Preface

THE STATED objective of the Aerospace Medicine Program is "to promote and maintain the physical and mental health of Air Force personnel. . . ." What more effective support could be given to this program than to assure that the food consumed by all personnel is of of prime quality; and that it can be consumed with the knowledge that it was prepared under the highest possible standards of sanitation?

This volume deals mainly with food preparation and service and the related aspects, such as water supply, sewage, garbage, and waste disposal. Chapter 2 involves the veterinary aspects of disaster control, but much of the emphasis is placed on the effects of disaster upon food supplies and the role of the veterinary specialist in providing food supplies following disasters.

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Material in this volume is technically accurate, adequate, and current as of September 1971.

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CHAPTER 1

Medical Aspects of Food Handling

MANY THINGS happen to food between the time it is prepared and the time that it is consumed. For one thing, it is handled by humans who are likely to make mistakes. These mistakes could affect the health, comfort, and morale of the consumer. Therefore, it is very important that foodhandlers receive proper training in, and adhere to, sanitary practices concerning food preparation, food service, and equipment maintenance.

2. In this chapter, you will learn about the various illnesses which can be transmitted by carelessly prepared food, or food that is handled by misinformed personnel. The controls and preventive measures for each type of illness and procedures involved in combatting a foodborne illness outbreak will be explained. You will learn of the health standards a foodhandler must meet and maintain, and also of the training required of the foodhandler. In addition, the sanitation requirements for food and beverage vending machines and non-Government food-processing plants will be discussed. Flight feeding is of concern to you and you will learn about diet precautions for flying personnel, types of prepared foods for in-flight use, proper handling, and the serving of foods aboard aircraft. We will be concerned with food service facilities, equipment, and sanitary handling and preparation of food. You will learn methods of conducting an inspection for sanitation of a food service facility and various tests for cleanliness. Identifying, locating, controlling, and eliminating insects and rodents from a food service facility will be discussed at length. You will learn proper procedures to follow should you have a foodborne disease outbreak within your area of responsibility and how to prepare all required reports related to the outbreak.

1. Foodborne Illnesses

1-1. "One Million Americans Victims of Foodborne Illness!" Fantastic? Yes, but this is the number of persons that the US Public Health Service estimates are affected each year by foodborne illness. The saddest part of this commentary is that most, if not all, of this misery could be prevented.

1-2. Why do these illnesses occur? Food poisoning or foodborne infection is caused by persons who prepare and serve food and who fail to apply *known* food protection measures. Acts of carelessness or ignorance lead to contamination of food with bacteria or with material which causes foodborne illness.

1-3. Most foodborne illness is caused by bacteria, but there are other causes. This discussion will present various causes of foodborne illness as well as related information which should help you determine the best course toward your ultimate goal—prevention.

1-4. **Definition of Terms.** A knowledge of the language to be used is essential; therefore, we need to define several common terms.

a. Food poisoning. Any poisoning, usually a gastroenteritis, of *abrupt onset* acquired through food. Foodborne intoxication is characterized by a grouping of cases in which the severity of disease is related to the amount of toxic food consumed. This suggests that it is due to *preformed elements.* It is caused by organic or inorganic substances including *bacterial toxins.*

b. Foodborne infection. This indicates illness caused by ingesting food or drinks which contain *microorganisms,* such as salmonella, shigella, streptococci, brucella, tapeworm, etc. Foodborne infection is characterized by *delayed* onset of symptoms and the severity is not necessarily related to the amount of infected food consumed. This suggests that it may be due to multiplication of organisms after they have been ingested.

c. Contaminated food. Food which contains the microorganisms or toxins capable of causing foodborne illness.

d. Infective food. Contaminated food in which the disease-producing organism(s) has increased in number to the extent of causing a foodborne illness in a susceptible unit.

e. Incubation period. The amount of time necessary for symptoms to develop after ingestion of contaminated food.

f. Ptomaines. By definition, ptomaines are bases formed under the action of bacteria or of metabolism. Ptomaines are found in decaying or putrifying vegetation or animal matter where it causes much of the stench. Little, if any, foodborne illness is caused by ptomaines. Ptomaine poisoning is a term used by many uninformed persons to describe all forms of foodborne illness. In this sense, it is generally a misnomer.

g. Vulnerable food. Food which is usually moist, high in protein, and low in acid.

h. Foodhandlers. All persons who will be present in places where unsealed food or drink is handled, processed, prepared, or served and who contact food or food contact surfaces with any part of their body or their clothing, other than solely as consumers or purchases of food. This includes duty in food service kitchens, bakeries, meat processing plants, and storage warehouses; flight kitchens; restaurants; food production points; snack bars; and club bars where alcoholic drinks are served. Included in this category of personnel are cooks, cook's helpers, bakers, bartenders, meat cutters, waiters, dishwashers, diet supervisors, diet specialists, mess attendants, food service stewards and attendents, vending machine attendants, and all persons who dispense ice cream or milk, such as base exchange attendants, plus household servants. The term "foodhandler" also includes personnel assigned such duties on a temporary basis, except for kitchen attendants (KA), janitors, and delivery men if they never contact food as described above.

1-5. Now that the language is understood, we need information about the types of foodborne poisoning or foodborne infections often encountered. Also, we should be able to classify foodborne illnesses, and to understand the symptoms and characteristics of each disease. Finally, we need to know the proper preventive measures for each type of illness.

1-6. **Food Poisoning.** The most common cause of food poisoning or intoxication is bacteria, although poisonous plants and animals and chemical intoxication are occasionally the cause of serious outbreaks. Bacteria cause food poisoning by releasing toxic products into the food; many of these bacteria are constantly present in healthy individuals. Chemical intoxication is often caused by preparing or storing food in containers made of materials which are toxic to man. Some plants and animals are naturally poisonous to man, but are sometimes prepared for food when this danger is not properly understood.

1-7. *Staphylococcal food intoxication.* Staphylococcus organisms are always present on our bodies but, luckily, not all types cause food poisoning. Only those specific types that produce a toxin will cause trouble. Toxin-producing staph may be found in the mouth and nose, infected cuts, boils, pimples, and on dirty hands and arms. Boiling usually does not destroy the toxin produced by staph. The only sure way to prevent *staphylococcus* food poisoning is to prevent the bacteria from getting into food and by storing the food under conditions which will not allow the staph to grow, even if present.

1-8. Staphylococci grow and reproduce in warm, moist, high-protein foods. Custards and cream-filled pastries are especially susceptible to staphylococcus intoxication. Meats, egg products, and salads made from meat, eggs, or mayonnaise are also frequent offenders. At temperatures between 45° F. and 115° F., food can become toxic within 3½ to 4 hours. Cold does not kill the bacteria, but it inhibits the growth and reproduction processes. High temperatures kill the organism but may not destroy the toxin which has already been produced.

1-9. Prevention is the key to control. Foodhandlers with open sores, boils, cuts, skin rashes, or gastrointestinal upsets should not be allowed to work until they are well and have been cleared for return to duty by a physician. Daily examination of foodhandlers by their supervisor is especially necessary to detect these problems. Education of foodhandlers, to convince them of the need to thoroughly wash their hands periodically throughout the day and after visits to the latrine, is a basic preventive measure. Use of wholesome products, clean utensils, proper handling techniques, and adequate refrigeration are vital. Also, an important rule to teach is "Keep hot foods *hot* (above 140° F.) and cold foods *cold* (below 45° F.)."

1-10. Symptoms of staphylococcus food poisoning may begin to occur in less than 1 hour and the illness usually reaches its peak in 3 to 4 hours. Symptoms may vary from mild nausea to extreme prostration with cramps, vomiting, and diarrhea. Recovery usually occurs within 24 to 48 hours; deaths have occurred as a result of staph food poisoning, but they are very rare.

1-11. *Botulism.* This spore-forming organism, *Clostridium botulinum,* grows in an absence of air and produces a highly fatal toxin which affects man even in very small amounts. *C. botulinum* lives in decaying animals, soil, silt of lakes, and is often found in animal intestinal tracts. Food that comes in contact with contaminated soil picks up this organism, then releases a toxin as it grows under anaerobic conditions. The toxin is destroyed by boiling for 5 minutes, but the botulinum spores are much more resistant. They may be killed by boiling for 5 hours at 212° F. or for 40 minutes at 221° F. (pressure cooker). This extreme killing requirement explains why underprocessed, home-canned, garden vegetables have been the source of numerous cases of botulism. Nonacid foods such as peas, beans, corn, and meat are the worst offenders.

1-12. Symptoms of botulism vary considerably, depending upon the amount of toxin ingested. Symptoms may appear at any time between 2 hours to 6 days (usually 18 to 36 hours) after consuming the toxin. They may include double vision, loss of control of eye movement, and difficulty with speech, swallowing, and breathing. These symptoms may progress until there is complete muscular paralysis. Mortality rate is usually high (33 to 50 percent) and death may occur within 3 to 8 days after poisoning.

1-13. Prevention of botulism is based upon proper preparation of vulnerable foods. Home-canned, nonacid foods should be avoided. Inspect all canned foods and discard bulging cans. When in doubt, throw it out. Don't taste to determine safety.

1-14. *Clostridium perfringens*. This is a toxin-producing, anaerobic organism which has gained considerable attention in recent years. It inhabits the intestinal tract of man and animals and is the most prevalent spore-forming bacteria in the soil. It is also a common cause of gas gangrene. The toxin produced is destroyed by boiling for 5 minutes.

1-15. Meats and poultry have been the chief offenders in outbreaks of foodborne illness involving *C. perfringens*. Unrefrigerated chicken broth provides an ideal culture medium. Rolled meat roasts, meat pies, and turkey are often the source of outbreaks. These types of foods or conditions afford the slightly anaerobic conditions which promote the growth and reproduction of *C. perfringens*. Improper handling and processing of poultry and meat increase the hazard of contamination. Improper removal of soil from vegetables has also caused outbreaks. Inadequate refrigeration, improper cleaning, and exposure of food to dust and air all contribute to the growth of *C. perfringens*.

1-16. Symptoms of *C. perfringens* foodborne illness are generally of short duration, usually 1 day or less, and complete recovery usually follows. The symptoms, which appear in 8 to 20 hours, include acute abdominal pain and diarrhea, chills, and fever. Nausea is mild, if present, and vomiting is uncommon.

1-17. Controls and preventive measures generally involve proper preparation and storage of meat and poultry dishes. You should:

a. Serve hot, immediately after preparation.

b. Cool (below 45° F.) leftovers rapidly and reheat (above 140° F.) them rapidly.

c. Use a meat thermometer to insure adequate thorough cooking of thick cuts and interior portions.

d. Limit depth of stews, gravies, etc., to 4 inches for refrigerated storage.

e. Insure proper techniques of handling and cleaning of vegetables and poultry.

1-18. *Nonbacterial poisons*. In addition to bacterial poisons, poisonous chemicals from higher plants and animals can cause symptoms when consumed. Among the offenders that have caused outbreaks of poisoning are fava beans, water hemlock, rhubarb leaves, mussels, some species of fish, shellfish which have eaten poisonous plankton, and some mushrooms. Two species of mushrooms, both of the genus *Amanita*, are very dangerous. Onset of symptoms from these mushrooms may occur within minutes to 2 hours after consumption of *A. muscarine*, or from 6 to 15 hours if due to toxin of *A. phalloides*.

1-19. Other types of nonbacterial poisons are those which do not originate from plants or animals. These are the inorganic chemical poisons. Included in this group are insecticides which have been used on fruits and vegetables; copper and cadmium-plated, enameled (antimony), or galvanized (zinc) pots and pans in which acid foods are prepared or stored; and lead, fluorides, and cyanides. These chemical poisons often cause violent symptoms which may begin in a very short time (10 minutes to 2 hours) after ingestion of the poison.

1-20. **Foodborne Infections.** In contrast to food poisoning, foodborne infection is caused by organisms which enter the body through the food chain rather than by toxins produced by organisms, or biological or chemical poison. There are numerous types of organisms which are capable of causing illness through foodborne transmission. They include bacteria, rickettsia, viruses, protozoa, and various parasitic helminths. The majority of cases are caused by bacteria and the salmonella and streptococcus groups are the most prevalent offenders; however, the virus causing infectious hepatitis is high on the list.

1-21. *Salmonellosis*. There are more than 1400 serotypes of salmonellae; among these is the notorious typhoid organism. Salmonella organisms cause a high percent of all foodborne infections; they are believed to be the most common cause of foodborne infection. The salmonella infections are common in animals and fowls; therefore, infection may result from eating improperly prepared, preserved, or cooked meats from these sources. Ground meat and sausage are especially vulnerable. Outbreaks often result from contamination of food from external sources. Foodhandlers, insects, and rodents may carry and transfer the organisms to food products. Rodents may contaminate flour and cause outbreaks from pastries and fillings.

1-22. Similar circumstances present in outbreaks of other foodborne illnesses will be found in an outbreak of salmonellosis. These circumstances are:

- Contamination of food capable of supporting growth of salmonella.

- Favorable temperature (45° F. to 115° F.).
- Sufficient time for organisms to multiply to a dangerous level (at least 4 hours).

1-23. Symptoms occur between 6 and 24 hours after ingestion (average 18 hours). They vary from slight nausea of short duration to severe headache, chills, fever, violent retching, colic, and diarrhea. Recovery make take from 1 to 3 days up to a week. Death has occurred but is rare except in highly susceptible groups such as young children, the aged, and those otherwise ill.

1-24. Control measures are similar to those involving other foodborne illnesses, and include:

- Cleanliness of food and foodhandlers.
- Noninfected foodhandlers.
- Proper handling, thorough cooking, and adequate storage of susceptible foods.
- Use of pasteurized dairy and egg products.
- Use of eggs whose shells have not been cracked.

1-25. *Streptococcal food infection.* The causative circumstances surrounding a streptococcal foodborne infection generally parallel those of staphylococcus and salmonella outbreaks. The incidence of streptococcal foodborne infection is less and the symptoms are milder than those previously discussed. These symptoms may begin 2 to 18 hours after ingestion of infective food. They often include vomiting, colic, and diarrhea.

1-26. The infectious agent is *Streptococcus pyogenes,* which causes sore throats and scarlet fever, and may be transmitted to food through droplet infection (spread by talking, coughing, and sneezing). Susceptible foods include poultry and eggs, potato salad, meat dishes, and low-acid foods. In addition to the controls for previously discussed foodborne illnesses, cleanliness and health (no upset stomach or sore throat) of foodhandlers, and proper sanitizing of multiuse eating and drinking utensils should be stressed.

1-27. *Infectious hepatitis.* Infectious hepatitis is a viral disease which occurs worldwide. Man is the reservoir. Sources of the infection are feces, urine, and blood from infected persons. The virus can be transmitted by person-to-person contact, through the fecal-oral route. It is generally transmitted through ingestion of contaminated food and water. Control and epidemiological investigation center around possible transmission by water, food, blood, or blood products. Special efforts should be made to improve sanitation and personal hygiene. Reduction of fecal contamination of foods and water should be stressed.

1-28. *Miscellaneous foodborne infections.* Many miscellaneous diseases not yet mentioned are transmitted through the food chain. These do not occur as often as those previously described. Among these are numerous intestinal parasites—such as pork, beef, and fish tapeworms, and other helminths; intestinal viruses—such as influenza; and bacterial diseases—such as brucellosis and TB; and many others—such as the aflatoxin from the mold *Aspergillus flavus.*

1-29. Many of these diseases are primarily diseases of animals, but are capable of infecting human beings through ingestion of the organisms in improperly prepared or processed foodstuffs, or by direct transmission from the animal. The source of infection is often food which has been improperly prepared or processed. Undercooked meats may contain tapeworms or trichinae; and raw milk from infected animals can be a prime source of brucellosis, diphtheria, Q-fever, or bovine tuberculosis. In most instances, veterinarians control these diseases through vaccination of herds or slaughter of infected animals where a cure is not possible or feasible. In trichinosis control, cooking of raw garbage to be used as hog food is the primary preventive measure. Veterinary meat inspection both before and after slaughter further controls the transfer of many animal diseases.

1-30. Control of the transmission point in some instances is the best method of prevention or transfer of many of these diseases. Pasteurization of milk is the intermediate control in brucellosis, Q-fever, and bovine tuberculosis. Pork must be cooked thoroughly to prevent trichinosis, and all other meats should be cooked adequately to control parasites. *Thorough cooking* (137° F. or higher) of *all* pork products is a realistic and satisfactory positive control.

2. Prevention of Foodborne Illness

2-1. There are many facets to the prevention of foodborne illness. Foodhandlers, facilities, and equipment involved in preparing and serving food are of primary concern. In this section, we will discuss the education and physical examination of foodhandlers, and the inspection of establishments and facilities.

2-2. **Responsibilities of Personnel.** The responsibilities associated with the prevention of foodborne illness lie to some extent with all personnel involved in the acquisition, handling, and processing of food. The base commander, of course, has the ultimate responsibility for sanitary operation of food service facilities and the enforcement of directives and standards pertaining to his organizations. The officer(s) in charge of food service facilities are directly responsible for operating the facilities and maintaining the established standards. The Medical Service has numerous responsibilities pertaining to food service sanitation and the prevention of foodborne illnesses. These responsibilities include the establishment of health standards for food service facilities and determining whether or not the facilities and equipment are adequate to maintain these standards; recommending adequate food service sanitation programs within the command; assisting in training food service personnel in personal hygiene and food service sanitation; and making recommendations for maintaining sanitary conditions in food service facilities on Air Force installations and in nearby civilian communities. When discrepancies are found, the medical inspector must be able to submit reports to the appropriate authority and recommend necessary corrective action in accordance with current directives.

2-3. **Examination of Foodhandlers.** There are several distinct aspects to foodhandler examinations. Medical examinations are required prior to employment; periodically as required by the Director of Base Medical Services (DBMS); and, if necessary, following illness. Examination by food service supervisory personnel is necessary to insure maximum day-to-day hygienic and physical well-being of foodhandlers.

2-4. *Medical examinations.* All foodhandlers will have successfully passed a medical examination before performing any duties involving food handling in appropriated or nonappropriated fund food service activities. The Major Command Surgeon and the DBMS will determine the necessity, frequency, and extent of subsequent examinations. Under certain circumstances in the CONUS, periodic examinations may not be necessary.

2-5. Medical examinations are designed to reveal chronic illness or medical problems which may exist at the time the examination is made. Clinical tests are made to insure that foodhandlers are free from active tuberculosis; to assure that salmonella, shigella, or *Endomoeba histolytica* are not being discharged in the stools; and to determine that pus-forming or other dangerous organisms are not being discharged from chronically infected ears, nose, skin lesions, mouth, etc. In addition, freedom from parasite ova directly infective to man is not mandatory; however, persons who are shedding ova of parasites not directly infective to man may be employed. Determination of infectious viral hepatitis should be made when possible. Immunizations for the appropriate geographical area must be kept current.

2-6. Results of medical examinations are recorded in the medical records folder. AF Form 535, "Medical Certificate—Foodhandler," will be prepared by the foodhandler's organization. The medical qualifications will be filled out and signed by the examining medical officer for each foodhandler. The certificate of the most recent examination on qualified food handlers will be kept on file where the food handler is employed.

2-7. *Supervisory surveillance.* Daily supervisory examination of foodhandlers is a very important aspect of disease prevention and, in the opinion of many, has equal or greater value than the periodic medical examination. This procedure, which is often overlooked, assures that hygienic standards and physical health (as best determined by visual examination) are maintained by all foodhandlers. Examinations and constant surveillance should insure that the following requirements are met by all foodhandlers.

a. Bathe daily.

b. Keep hands clean at all times. They must be washed with soap and warm water when reporting for duty, immediately after each visit to a latrine, and after handling animals, fish, or fowl. In areas where this practice is not ingrained, the food service officer and supervisors will exercise maximum ingenuity to accomplish conformance.

c. Wristwatches, bracelets, and rings (except wedding bands) will be removed prior to and during food preparation and serving.

d. Keep fingernails clean and cut short.

e. Facial hair will be trimmed to 1 inch or less.

f. Wear clean outer clothing, preferably white in color, while on duty. The upper garments must cover the armpits. Foodhandlers will wear acceptable head covers; persons with hair longer than 6 inches will wear hair nets or strong-holding (lacquer-type) hair spray.

2-8. Kitchen attendants (KAs) used in preparing food to be cooked will be inspected by the supervisor for cleanliness, absence of open wounds, and obvious infections (such as colds or boils). If local extenuating circumstances necessitate the utilization of KAs as servers of prepared foods, supervisors will maintain maximum surveillance over each operation in which the KAs are engaged.

2-9. **Food Storage Techniques.** Procedures and techniques used by food service personnel in storing, preparing, and serving food rank high in importance when you evaluate the possible causes and prevention of foodborne illness. Techniques mentioned here are points of special emphasis. This discussion concerns you in two respects, i.e., improper food handling is conducive to foodborne illness and/or food spoilage.

2-10. *Temperature control.* Proper temperature control is probably the most important aspect of storage. Time limitation, types of containers used for storage, ventilation of storage areas, and the protection of stored food are other important considerations.

2-11. Temperature control encompasses several aspects of food storage. The previously mentioned general rule is to keep hot food *hot* (140° F. or more) and cold food *cold* (45° F. or less). In addition, proper handling of frozen foods is important. Frozen foods must be defrosted in a well-ventilated cooler maintained at a temperature not exceeding 45° F., or cooked from the frozen state. Defrosted foods will be used as soon as defrosted, or held no longer than 24 hours. Leftovers and/or defrosted foods will not be frozen. When it is impossible to defrost frozen foods as stated above, the frozen food may be held at room temperature for a maximum of 6 hours and then placed into a 45°-F. cooler to complete the thawing, during which time the surface temperature of the food should never exceed 45° F.

2-12. *Time.* Time is closely related to temperature control and may in certain instances be the determining factor in whether or not food is safe for consumption. Foodhandlers should know and adhere to the following time limitations that are placed on holding food

a. Defrosted foods must be used as soon as defrosted; they must not be held longer than 24 hours.

b. Leftover foods will be immediately labeled (time and date), refrigerated, and used within a 24-hour period. Food items which have gone directly from cooking to the refrigerator, such as large roasts and whole turkeys, may be held for 48 hours. Foods which are notably poor growth media for bacteria such as bread, fruit pies, and high-acid-content foods may be stored longer than 24 hours but should be used soon enough so that palatability is not lost (normally 48 to 72 hours).

c. Prewrapped or preprepared sandwiches will be prepared not more than 36 hours before issue or sale. They must be consumed within 5 hours after preparation or, if refrigerated below 45° F., they may be kept not more than 36 hours. In addition, sandwiches prepared with hot meats or other hot products will be for immediate consumption; however, they may be eaten within 5 hours if they are maintained no lower than 140°F. After 5 hours they will be disposed of as garbage.

d. Vulnerable foods such as poultry, meat, water food, dairy products, and egg products will be prepared in the minimum time before being served and, unless kept at a temperature of 140° F. or more, will be covered and refrigerated until time of serving and must be maintained above 140° F. or below 45° F. while on the serving line.

2-13. *Dangerous foods.* Particularly dangerous foods (hash, creamed soups, gravies, dressings, bread puddings, certain cheese or egg casseroles, creamed meats, etc.) will not be refrigerated in pans over 4 inches deep, since the center of the mass will not be adequately cooled. Large bulky meat items such as turkeys, hams, and roasts cool slowly; therefore, they will be placed in a well-ventilated refrigeration unit immediately upon leaving a 140° F. (or higher) heating unit. Particularly dangerous foods will be prepared in the minimum time before being served (4 hours or less).

2-14. *Storage containers.* The type of container used for storage of food is another important consideration. Containers must be clean, free from cracks or chips, and not made of a material (zinc, antimony, etc.) which can potentially convey a chemical poison to its contents. Furthermore, food containers must be placed on racks or dunnage to allow adequate ventilation. The minimum space required for proper ventilation is 4 to 6 inches from floors and walls in cold storage and 4 to 8 inches for products in dry storage. Stored foods should always be kept covered.

2-15. The use of galvanized containers will be limited to the transportation and temporary storage of water, peeled raw potatoes in water, and dry foods. Meat, fruit, salad, lemonade, tea, coffee, fruit juice, etc., will not be placed in them nor will they be used for cooking food. The container (not just the lid) should be labeled as to its contents.

2-16. *Nonfood products.* Detergents, cleaning agents, and other nonfood products will be clearly labeled and stored in an area *separate* from food products.

2-17. **Dishwashing Techniques.** All forms of pathogenic organisms, including the most resistant spores, are removed from dishes and other eating utensils, or killed, when proper dishwashing techniques are applied.

2-18. *Equipment and utensils.* Equipment must be kept clean to prevent contamination of food. The best time to clean it is immediately, but not later than 3 hours after use. Soiled equipment will be cleaned and sanitized before use. Equipment in poor condition; chipped or cracked china, glass, or plastic containers; utensils with cracks, chips, or pits; or any utensil with roughness which makes thorough cleaning difficult will not be used. Cleaned and sanitized glasses, dishes, trays, and utensils will be stored in a manner to prevent contamination. Glasses, cups, bowls, etc., will be stored inverted on racks of suitable design to protect them from dust, dirt, insects, and fingers. Serving trays may be stacked inverted after they are properly cleaned and dried. Silverware will be stored with the handles presented to the user. Cutlery cylinders with perforated sides and bottoms will be used. These must be kept elevated above floor level.

2-19. Dirty china and trays are evidence of poor dishwashing and will often bring more complaints to a food service facility than anything else. Often, dishes and utensils may *appear* clean, but laboratory procedures conducted by medical personnel may reveal large numbers of bacteria on them.

2-20. *Mechanical dishwashing.* Proper dishwashing consists of a combination of a number of distinct steps. An evaluation of dishwashing must take into account these steps and their relationship to the total operation. It is essential to examine not only the machine's capability, but also the work habits of the person who operates it. Dishwashing operations must comply with AFM 163-8, *Food Service Sanitation.*

2-21. On the bussing cart and at the dirty dish table, sort the items to be washed. Like items, requiring the same type of racks, are usually sorted together. Place the silverware in a hand-dishwashing detergent solution for presoaking.

2-22. Remove gross soil and rack the dishes at the same time. Racks will be constructed of nonmarking corrosion-resistant welded wire or plastic. The main problem areas in this procedure are insufficient waste removal, overloaded racks (dishes overlapped, stacking of bowls and cups), and use of the wrong racks. Flat items (such as plates) must be tilted in the rack so that the eating surfaces are sprayed from above and the bottoms from below.

2-23. Each facility is equipped with either a hand hose and nozzle or a mechanical prewash unit, integral to the machine, where the soil (food debris) is loosened with a water spray. The need to empty, clean, and refill the wash tank is directly related to the prewash operation. If the person using the dishwasher is diligent in removing as much soil as possible during this step, he will not have to change water in the wash tank as often as he will if not diligent. Spray dishwashers are designed to remove soil films, not large food deposits, and cannot do the job adequately if large amounts of food are left on the dishes. The temperature of the prewash water should be between 110 and 120° F. This temperature range allows removal of food and grease from dishware.

2-24. The washing cycle involves a properly selected detergent solution of the proper temperature which is sprayed forcefully against all food contact surfaces to accomplish the washing action. Wash water temperature should not drop below 140° F. nor should it exceed 160° F. Detergent activity is often decreased when the temperature exceeds 160° F. One most important factor of this operation is cleanliness of the wash arms. If they are clogged with food particles, string, lime deposits, etc., they lose efficiency, and the machine's ability to wash is impaired. Another important factor is the concentration of detergent in the washwater. There must be some means of replenishment to offset cross-dilution by the final rinse. The best way is by means of a detergent dispenser. If this piece of equipment is not present, a previously determined quantity of detergent should be added with each rack of dishes to accomplish replenishment. The washwater must be relatively free of small food particles which tend to stick to utensils being washed and to resist rinsing action. The accuracy of the installed wash section thermometer should be checked periodically by removing a scrap tray and testing the water temperature in the tank with a hand thermometer when the machine is shut off. The temperature may also be checked in the power rinse tank.

2-25. The function of the recirculating rinse cycle is to remove detergent and to heat dishes, etc., to a sanitizing temperature. The water temperature should not be below 160° F. nor should it exceed 180° F. Besides the sanitizing temperature provided, the increased heat causes the dishes to air-dry rapidly and tends to reduce water spotting and films caused exclusively by hard water. It is important to check that the rinse-arm tubes are open and free of foreign deposits that reduce their efficiency.

2-26. The nonrecirculating fresh-water rinse provides the thermal sanitization that is so vital to the protection of food contact surfaces from pathogenic organisms. The water temperature in this cycle should range between 180 and 195° F. The final rinse jets, being quite small, are subject to clogging from hard-water scale deposits. These jets or nozzles should have routine examinations to be sure they are not materially reduced in size by mineral build-up or are not plugged by particles of scale from the hot-water supply line.

2-27. Only air-drying is authorized. If the dishes do not dry in about 1 minute, something is wrong. The finished dishes may not be hot enough to cause the remaining water to vaporize rapidly, or poor ventilation in the dishwashing room may be causing the air to reach such a high humidity that it will not accept additional moisture. Trays and silverware are especially bad in this respect, but a shake of the rack will help dislodge most of the water droplets and reduce drying time.

2-28. Dishes must be allowed time to dry before they are unloaded from the racks. If unloading is done immediately upon exit from the dishwasher, wet dishes will result. As the personnel unload the racks, they should inspect for dishes that were improperly cleaned. To aid them in this, an adequate level of light should be provided (50–100 foot-candles). Inevitably, certain dishes will come through which have not been properly cleaned. These must be rewashed.

2-29. Store dishes and other food contact surfaces in such a manner as to reduce the chance of contamination to a minimum. Bowls, glasses, cups, and similar items should be stored inverted. Plates and saucers should be stored in lowerators or in cabinets.

2-30. *Hand dishwashing.* The most satisfactory arrangement for sanitizing food contact surfaces, other than with properly operated mechanical equipment, is by the use of a three-compartment sink. Manual dishwashing involves certain prescribed and important procedures. First, the utensils must be scraped free of gross soil. Next, they are washed in a 110-to-120°-F. detergent solution, in the first compartment sink, until all visible food particles and grease have been removed. From the first compartment, the utensils and tableware (including glasses, cups, trays, and silverware) are passed to the second compartment, which contains clear, warm rinse water (usually about 150° F.). Here the soapy water that clings to them from the washing process is rinsed off. The third compartment is provided for sanitizing the utensils and tableware, and the hot-water or chemical method is used.

2-31. The hot-water method is just what its name implies. Utensils are completely immersed for 1 minute or more in hot water maintained at a temperature of at least 180° F. The 180° F. temperature is not to be guessed at. A thermometer must be used to assure that this temperature is maintained. Water at this temperature is much too hot for a person to put his hand in. Therefore, a dishbasket, dish rack, flatware container, or other container with a handle must be used to contain the dishes, etc., while they are immersed in the hot water. This permits easy removal of the utensils from the sanitizing compartment for drying. Whenever hot-water sanitization is not available, the chemical method is to be used. The most common chemical compounds used for this type of sanitation are hypochlorites and iodophors. Chemical sanitization is best accomplished by immersing dishes, etc., into a 200-parts-per-million hypochlorite solution (100–140° F.) for not less than 2 minutes or into a 25–75-parts-per-million iodophor solution (75–125° F.) for not less than 1 minute. Equipment that is too large to immerse may be sanitized by a hot-water (180° F.) spray rinse for 10 seconds, or by spraying or swabbing with a chemical sanitizer of proper strength. Only air-drying is authorized.

2-32. *Single-use containers*. If proper dishwashing facilities are not provided at food establishments, disposable paper cups, paper plates, spoons, etc., will be used for serving foods.

2-33. **Foodhandler Training.** Proper and adequate training of foodhandlers in the principles and practices of food service sanitation is of vital importance in the prevention of foodborne illness. AFM 163-8 requires that instruction in this subject be administered to all foodhandlers and supervisors. This training will be repeated annually or as often as the DBMS determines necessary to insure that all foodhandlers, including supervisors, are aware of their responsibilities in disease prevention. The base veterinarian or other qualified Medical Service personnel will conduct the program. As a veterinary specialist, you may be asked to help present this training.

2-34. *Preparation*. You must make adequate preparation and know your subject if you are to present a course of instruction. The more research you do to prepare yourself, the more self-confidence and poise you will have. As a result, your course will be more effective. If you are asked to conduct such a course, consult as many publications as possible that deal with the subject. The following are excellent.

a. AFP 161–22, *Sanitary Food Service Instructor's Guide.*
b. AFP 161–24, Handout Sheets—*Sanitary Food Service and Personal Hygiene.*
c. AFM 146-7, *Food Service Management.*
d. ESM 25–4, *Exchange Service Food Operation's Manual.*
e. *Quantity Food Sanitation*, Karla Longree.
f. *Sanitary Techniques in Food Service*, Karla Longree.
g. *Foodborne Illness—Cause and Prevention*, Kelly Vester.
h. *Planned Sanitation—Prestige and Profit*, Kelly Vester.

2-35. *Scheduling of classes*. Scheduling of classes must be arranged jointly with the supervisory personnel of all food service activities concerned. The classes should be mandatory meetings approved by the base commander. Remember that the facilities cannot cease operation in order to attend the classes; therefore, each subject hour must be presented at least two times. As a suggestion, each class session could be given the *last* 1½ hours of a morning shift one day and the *first* 1½ hours of the afternoon shift the following day. Thus, the afternoon shift would arrive 1½ hours early, to attend their session; and the morning shift would remain 1½ hours after going off shift, to attend their session. This would then be repeated for each subject hour.

2-36. *Location of classes*. You will want a central location, equally accessible to all food service personnel. Too large a facility can be as undesirable as too small a facility; therefore, attempt to reserve a location (Service Club, Officer's Club, or NCO Club) that will accommodate the attendance and lend adequate effect (sound, light, ventilation, and seating) to the training environment.

2-37. *Lesson plans*. Each lesson should be presented from a well-developed lesson plan. A lesson plan should include a stated objective of what the student is expected to learn from the lesson and should be outlined to show step-by-step development of the lesson. The Instructor Activity column should be used as a guide and not as a word-for-word lecture. After your lesson plans are developed, you should try a "dry run" to develop self-confidence and timing. A foodhandler training course, complete with lesson plans and caricature 35-mm color slides, is available for use by veterinary personnel. Consult your command veterinarian concerning the availability of this material.

2-38. Upon completion of the course, an AF Form 1256, "Certificate of Training," will be signed by the officer in charge of the training program, and will be issued by the DBMS to each individual who satisfactorily completes the course of

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instruction. Minimum requirement for satisfactory completion will consist of attendance at 75 percent of the classes during the course of instruction, and a satisfactory grade on the examination.

2-39. The information presented here has been aimed at a basic course applicable to all activities. Your special needs should be determined by a review of the discrepancies frequently noted during surveys and inspections. In developing your course, keep in mind that you are training *foodhandlers* and *not* Medical Service personnel. Be careful of over-using medical terminology. Discuss only that material which the foodhandler has a *need for;* do not fill the course with material which is only *nice to know*. Remember—the most unpredictable aspect of foodhandling is the *human element*. You must try to convince the student that sloppy habits and faulty techniques on the part of the foodhandler are the most likely causes of foodborne illness. Motivate them to do their work correctly; in this way, they and the Air Force will benefit.

3. Food and Beverage Vending

3-1. Whether it be coffee break, lunch, or midnight snack, chances are good that at least once a day you will take advantage of the convenience of a mechanical food or beverage dispensing device—the vending machine. Depending upon the size of the base, there are probably some 300 to 500 vending machines on your base. Insuring the safety of the food and beverages obtained through these machines is an important part of the veterinary program. This responsibility has two distinct aspects: First, the machine, operator, delivery vehicle, and area in which the machine is located; and, second, the plant facilities and personnel involved in preparing, packaging, and storing the products for the machines.

3-2. **Definition of Terms.** The USPHS pamphlet, *Vending Food and Beverages;* and AFM 163-8, *Food Service Sanitation,* are the sources of the following definitions of terms that are pertinent to this section.

a. Vending Machine. Any device which, upon insertion of a coin or coins, dispenses food or beverage, either in a bulk or package.

b. Catering Point. Restaurant, commissary, caterer, or any other place in or from which food, beverage, or ingredients are kept, handled, prepared, stored, or sold for subsequent dispensing through vending machines.

c. Machine Location. The room, inclosure, space, or area where one or more vending machines are installed and operated.

d. Readily Perishable Foods. Any food or beverage or ingredients consisting in whole or in part of milk, milk products, eggs, meat, fish, poultry, or other food capable of supporting rapid and progressive growth of microorganisms which can cause food infection or food intoxication. Products in hermetically sealed containers processed by heat to prevent spoilage, and dehydrated, dry, or powdered products so low in moisture content as to preclude development of microorganisms are excluded from the terms of this definition.

e. Hot Food or Beverage. Liquid food or beverage, the temperature of which at the time of service to the consumer is at least 140° F.

f. Product Contact Surface. Any surface of the vending machine, related equipment, or containers which comes into direct contact with any food, beverage, or ingredient.

g. Adulterated. A food is adulterated if:

(1) It bears or contains any substance which may be injurious to health.

(2) It consists in whole or in part of any substance which is in any way unfit for human consumption.

(3) It has been prepared, packed, or held under conditions which may have rendered it injurious to health.

(4) The container is composed in whole or in part of any substance which may render the contents injurious to health.

h. Operator. Any person, who by contract, agreement, or ownership takes responsibility for furnishing, installing, servicing, operating, or maintaining one or more vending machines.

3-3. **Service and Inspection.** The safety of food or beverages received from a vending machine depends upon a combination of factors. The products must consist of unadulterated ingredients that are prepared and delivered under sanitary conditions and are held in a safe environment until purchased. The catering point must be maintained and operated in a sanitary manner and must be inspected and approved by the Medical Service.

3-4. **Foods Dispensed.** All products and ingredients intended for vending must be clean, wholesome, and free from contamination and adulteration. Wet storage is prohibited. The following types of food are prohibited for sale in automatic vending machines unless they are acidifed below pH 5.0.

- Ham salad.
- Egg salad.
- Chicken salad.
- Cream-filled pastries.

3-5. *Chilled vulnerable foods*. These foods must be dispensed to the consumer in the original individual container or wrapper into which they were placed at the catering point, or be dispensed into single-service containers. Sandwiches and other food items made of readily perishable ingredients that are packed for vending machines must be permanently and conspiciously marked to show

the date and time the item was prepared. These foods will be placed in the vending machine within 12 hours of preparation and removed from the machine within 36 hours. Similarly, fresh dairy products will be coded and delivered to the machine within 48 hours of packaging and will be removed from the machine within 7 days from placement. Frozen foods (ice cream and ice-cream sandwiches) will be removed from the vending machine within 90 days of packaging."

3-6. *Readily perishable foods.* Readily perishable foods or ingredients within the vending machine must be maintained at a temperature which is less than 45° F. (for cold foods) or more than 140° F. (for hot foods). Machines must contain automatic shutoff controls so that any time the temperature varies above or below the limits, it will not dispense until serviced by the operator. In addition, machines must be provided with a thermometer, accurate to ±2° F., to indicate air temperature of the food storage compartment. While in transit, readily perishable foods must also be maintained at a safe temperature (below 45° F. or above 140° F.).

3-7. *Exempted foods.* The limitations stated thus far *do not* apply to carbonated beverages or canned or dried foods when the bottle, can, or package is dispensed sealed and subsequently opened by the consumer.

3-8. **Machine Location.** Machines must be so located as to promote cleaning and eliminate insect and vermin harborage. They must be at least 6 inches from walls and floor, or mounted on rollers, or be small and lightweight so they may be easily moved. If adequate space is allowed between machines and walls, machines may be sealed to the floor to prevent seepage and insect and rodent infestations. The immediate surroundings of each vending machine must be maintained in a clean condition.

3-9. **Food Contact Surfaces.** All food contact surfaces of vending machines must be smooth, kept in good repair, and free of breaks, corrosion, open seams, cracks, and chipped places. All joints and welds in food contact surfaces must be ground smooth and polished. All internal angles and corners must be rounded to permit proper cleaning.

3-10. All multiuse parts of vending machines which come into direct contact with readily perishable foods, beverages, or ingredients must be removed from the machine at least daily or at each servicing. These parts must be thoroughly cleaned and effectively sanitized each time they are removed. The DBMS will determine frequency of cleaning necessary for parts which come in contact with other than readily perishable foods. A record of all cleaning and sanitizing should be maintained at each machine by the operator.

3-11. Prior to installation of any machine, vendors are required to furnish a certificate declaring that the machine meets construction specifications of the *National Sanitation Foundation, NAMA*, or other agency recognized by the surgeon as having an equivalent testing program.

3-12. **Inspection.** Upon entering the base, and before servicing machines, operators are required to stop at the veterinary office to have the products inspected. You should arrange to accompany the operator at routine or unannounced intervals to inspect machines for cleanliness and to insure that operators are complying with directives on removal of readily perishable foods. These visits provide an opportunity to observe the conduct, habits, and appearance of operators and the areas in which vending machines are maintained.

3-13. **Plant Inspections (Military Standards Evaluation).** Products destined for use by military installations are prepared at numerous food-processing plants. All such plants or establishments handling, manufacturing, processing, storing, freezing, or supplying foods for use by the Armed Forces are subject to the sanitary approval and surveillance considered necessary by the Armed Forces. The only authorized exceptions are listed in AFR 163-2, *Veterinary Food Inspection.* Plants are inspected by medical personnel who use an applicable Military Standard as a guide.

3-14. *Military Standards—checklist.* In many instances, there are specific Military Standards which cover individual types of product processing. e.g., poultry processing, milk plants, bakeries, etc. For products for which no specific Military Standard has been developed, MIL-STD-668A, *Military Standard Sanitary Standards for Food Plants,* will be used. Inspection checklists are contained as an appendix to the applicable Military Standards. Local reproduction of the checklist is authorized and will be necessary to supply your requirements. Appendix A at the end of this volume contains the checklist from MIL-STD-668A. As you continue through the following explanation of major points and completion of the checklist, use appendix A as a guide to help you better understand its use.

3-15. *Defect points.* Individual sanitary defects in the checklist are given assigned defect points in column 2. They range in value from 0 to 5. and some are designated "critical." You may assign a numerical rating (0 to 5), according to your judgment of the magnitude or severity of the discrepancy. These assigned values are recorded during the inspection in column 3. Line out all defects and their assigned defect points that are not applicable to the plant being inspected. In instances where you consider a defect to be so gross as to constitute a serious health hazard, delete the numerical rating in column 2 and write the word "critical" in columns 2 and 3. Critical defects must be fully explained in the *Remarks* section in sufficient detail to clearly describe the condition which resulted in such a rating. At the end of the inspection, total the defect points in column 2 (exclude those you lined out) and also total the defect points you assigned in column 3. Any time a critical defect exists, you must complete your inspection, but you cannot total the defect points and the plant cannot be recommended for approval.

3-16. *Sanitary compliance rating (SCR).* Using your totals of columns 2 and 3 on the checklist, compute the establishment's rating by using the following formula:

$$\frac{\text{Sum of column 2} - \text{Sum of column 3}}{\text{Sum of column 2}} \times 100 = \text{SCR}$$

A plant must attain an SCR of 90 or higher to qualify for listing in the *Directory of Sanitarily Approved Establishments for Armed Forces Procurement.*

3-17. Plant inspection can be easily summarized by emphasizing the similarity between the requirements of *any* food processing plant and your local dining hall. All detailed requirements concerning building construction, employee health and hygiene requirements, water supply, utensil cleaning and sanitizing, etc., are the same. The exception is that health certificate 5 must only comply with local requirements. You will be working with local health department authorities, but your recommendations will determine whether or not a plant is approved or disapproved.

5. Medical Inspection of Food Service Sanitation Facilities

5-1. Inspections should be planned and made with one broad objective in mind—you are there to *help!* Your main concern is to prevent foodborne illness by revealing major discrepancies in the food service operation. Your effectiveness will depend upon your ability to create and maintain a harmonious, yet firm, relationship with supervisory personnel of the establishments. Every inspection should be viewed as an excellent opportunity for the *health education* of supervisors and foodhandlers. Don't just point out discrepancies, but add a discussion of possible consequences and reasonable solutions.

5-2. **Establish Rapport.** The importance of establishing rapport with food service supervisors cannot be overemphasized. There will be occasions when you must make comments concerning operations or personnel. The comments *must* be accepted as *constructive* criticism; any attitude to the contrary will nullify your effectiveness.

5-3. A good working relationship will depend to a great extent upon your ability to gain the respect of the food service personnel. The basis for this respect will begin with your first contact. Make your first visit a "social" call. Get acquainted with the supervisor; acquaint yourself with the facility. Do not make a report—make a *friend*.

5-4. **Conducting an Inspection.** During an actual inspection, you must maintain your friendly air, but this is only a small part of gaining the necessary respect. You must display good manners, military formality, and a firm attitude. You must meet or exceed the standards of appearance, health, and personal hygiene required of the foodhandlers. This includes a valid health certificate, clean clothing, clean hands and nails, haircut, and the wearing of a cap during the inspection. Know the job and be able to answer quickly and correctly questions that may arise regarding sanitary foodhandling practices. The veterinary officer or NCO should make the actual inspection, and should be assisted by an airman. The OIC and NCOIC should inspect all major food service facilities at least once a month and every facility each time an "unsatisfactory" report is submitted.

5-5. As an inspector, you should arrive at the facility with everything necessary to complete the inspection. This includes clipboard, report forms, carbon paper, and pencils. You should also carry a thermometer and any special equipment you will need for the particular facility, e.g., finger-plate culture plates, swab test supplies, ultraviolet light, etc.

5-6. When you arrive, contact the individual in charge. State your name and why you are there, and ask him to accompany you or have someone accompany you. Develop an inspection routine whereby you do not overlook any aspect of the facility; for instance, proceed always in one direction (clockwise or counterclockwise around the facility); do not ramble haphazardly around the building. Point out discrepancies as you note them; ask questions as required, and make appropriate notes concerning comments on why certain conditions may exist. Be sure your comments are valid. *Don't nit-pick*. Remember there is operational "dirt" and there are procedural discrepancies. You must use good judgment in deciding what constitutes a major discrepancy and what is a minor condition.

5-7. As you make your inspection, set a good example. Wash your hands often if necessary; don't *you* spread dirt or disease. Be careful how you handle food and utensils. During an inspection, you are the center of attention. You are "under the microscope" and open for criticism if you err.

5-8. When is the best time to make an inspection? Any time is appropriate. Inspections may be announced or unannounced; each type has its purpose. Inspection times should be staggered to meet all situations, all days and all hours including preparation times and serving times. The only time to verify that foodhandling techniques and procedures are hygienically adequate and proper is during the preparation, serving, and "cleaning up" periods.

5-9. *Facility cleanliness*. When you are conducting your inspection, for what do you look? First, look at the walls, ceilings, windows, exhaust ducts, and screens; they should be free from dirt, dust, and grease. The floors of the dining hall should be carefully swept, using a sweeping compound or damp mop after each meal. *Remember* that dry sweeping is prohibited. The floors of the kitchen should be kept clean by washing or mopping with hot, soapy water.

5-10. Observe the steam tables, drip trays, coffee urns, water fountains, and griddles to make sure that they are cleaned after each meal. Kitchen tables used for food preparation will be thoroughly cleaned and sanitized after each use.

5-11. As you make your inspection, carefully check all food contact utensils, including meat grinders, knives, meat slicers, can openers, pots and pans, and other utensils.

5-12. The outside area of a dining hall is very important, so don't forget to inspect this area. At permanent fixed installations, concrete *unscreened* garbage stands will be constructed at all facilities serving food. A curb at least 4 inches high should extend around the entire stand, and the stand should have hot and cold running water. The adequate and sanitary disposal of garbage and trash is an important factor in facility cleanliness because this refuse provides food for houseflies, roaches, and rodents, and serves to attract them to the vicinity of food service facilities.

5-13. *Tests for cleanliness*. A surface free of visible soil may still be capable of spreading disease. Tests have been devised for checking various surfaces to assure you that the surface is indeed clean. These include the finger-plate culture; the rinse test for bottles; the swab test for equipment with large, rough, or irregular surfaces; the contact-plate test for small, smooth surface utensils which can be pressed directly on a small surface of culture medium; and the fluorochrome-dye test for residual soil film. Other less time-consuming tests are available for quickly determining the efficiency of soil removal techniques. They include the Safranin dye test, salt test, tissue test, rinsability tests, and test for cleanliness of glasses. All these tests are fully explained in appendix B of this volume.

5-14. Your aim is to prevent foodborne illness, and a dirty floor behind a piece of equipment is considerably less of a health hazard than a scrupulously clean foodhandler with boils, URI, or other infectious disease. Let this also be an occasion to double-check the food inspection. Inspect food on hand for condition, and make sure it is from an approved source.

5-15. **Inspection Critique.** Before leaving the establishment, critique the inspection with the supervisor. Copies of work order requests or supply requests may be on file, which, if honored, would correct discrepancies. In a report of inspection results, such comments should be made to indicate that efforts have been made to correct unsatisfactory conditions. Supervisors will appreciate such recognition and will generally respond with increased cooperation on future visits.

5-16. **Inspection Reporting.** Reports can affect the value of an inspection. An inspection *form* is *not* the most effective method of reporting inspection results. Forms may serve well as a checklist to insure that all aspects of the operation have been observed. A copy of an inspection form should be left with the supervisor of the facility to help him in correcting discrepancies. The individual who accompanies you on the inspection should sign your copy; this copy should be maintained in your file. On subsequent visits, it may serve to remind you of conditions which existed at the time the inspection was made. A report should reflect individual effort directed at each establishment; it should not be a check-off inspection sheet which takes the form of a "gig list."

5-17. **Rating the Establishment.** In determining results of an inspection, all discrepancies should be considered with regard to their public health significance. When applying this significance in the form of a "satisfactory" or an "unsatisfactory" rating, you must determine whether or not an immediate or potential health hazard exists, or if a discrepancy is due mainly to poor management or to careless employees. A point system of scoring is not generally acceptable in determining results. This system too often leads to "unsatisfactory" ratings resulting from a number of minor discrepancies, whereby one major discrepancy may involve an immediate health hazard, yet not carry enough points to rate an establishment unsatisfactory.

5-18. The Chief of Aerospace Medicine and the DBMS should be kept informed on the conditions of all base food service facilities. Check with them to find out which reports they wish to see and how frequently. All unsatisfactory reports should be routed through the DBMS.

6. Insect and Rodent Control

6-1. As a veterinary specialist, your interest in insects and rodents will center around those which affect food products. Most of these affect stored food and are generally called economic pest insects. There are others, of course, which may interest you from a personal standpoint—such as mosquitoes, bedbugs, ticks, and lice—but you generally will not get involved in seeking or controlling these types.

6-2. Your main function in control of these pests is in recognizing signs of their existence, notifying the proper agency, and requesting control measures. Therefore, you must know who is responsible for the various aspects of control.

6-3. **Responsibilities.** Responsibilities for various aspects of pest control are defined in AFR 91-21, *Pest Control;* and AFR 161-1, *Control of Vector-Borne Diseases.* Major commands, the Director of Base Medical Services, and the base civil engineer have been given specific responsibilities under the provisions of these regulations.

6-4. *Major commands.* Major commands (1) insure that effective preventive and corrective pest control measures are established and accomplished; (2) provide qualified technical supervision for personnel engaged in these operations; (3) provide for training of personnel engaged in pest control; (4) insure that field supervisors are competent; and (5) issue AF Form 483, *Certificate of Competency,* to those field supervisors found qualified.

6-5. *Director of Base Medical Services.* The Director of Base Medical Services is responsible for investigation of the identity, source, and prevalence of pests which affect health, comfort, or efficiency of personnel. He recommends personnel protective measures; recommends measures for controlling or preventing breeding of animal reservoirs and vectors of diseases, and evaluates effectiveness of these controls; and provides technical guidance regarding safe use of pesticides.

6-6. *Base Civil Engineer.* The base civil engineer plans, initiates, and supervises pest control measures. He insures that pest control personnel are trained and certified, investigates factors relating to economic pests, and inspects and determines the effectiveness and safety of applied control measures.

6-7. **Preventive Storage Practices.** Careful periodic inspection of stored food is essential to the control of insect pests. Incoming shipments should be carefully inspected, and samples should be taken from as many different containers as possible. Surface examination will reveal the presence of heavy infestations, while screening of the material is often necessary to detect lighter infestation. Inspection of floors and areas around storage sites will often reveal the presence of live insects which have gotten out of containers, and this is usually an indication of a very heavy infestation. Spilled food that has leaked out of torn bags should also be surveyed, since these spilled products, if not removed, will attract additional insects and the infestation may increase.

6-8. Loose materials should not be stored in wooden storage bins. Instead, these products should be stored in clean garbage cans with tight-fitting lids, as is the standard procedure in dining halls. Materials which are subject to insect infestation should be stored on pallets of wood, so that no containers are directly on the floor. This allows easy rotating of stock so that older material is used first; otherwise, material which might be highly infested may become a heavy source of infestation, which may spread to the entire warehouse. New stock should not be placed next to a small amount of old stock, since this will lead to immediate infestation of the new material if the old stock is infested.

6-9. Ventilation is important in the storage of dried foods such as cereals. These foods should be stored so that a space of not less than 3 feet separates each wooden pallet and each stack and the wall. High humidity and warmth will increase the reproduction rate of pest insects. All possible steps should be taken to avoid these conditions. Ventilators should be kept open during periods of dry weather and closed when the humidity is high. Dried foods are not affected by cold temperatures, but the insects which they harbor may be killed or their reproductive rate may be slowed by cold. Thus, it is well to keep warehouses as cold as possible if no goods that may be affected by freezing are stored there.

6-10. **Identification and Control.** The economic pests that infest dried foods may be classified in one of two categories. There are those that infest grains and cereals, and those that infest dried fruits and vegetables.

6-11. *Grain and cereal pests.* Grain and cereal pests include the following:

- Cadelle beetle—cuts into boxes.
- Confused flour beetle—worst pest of prepared cereals.

- Indian meal moth—attacks grain, cereal, and crackers.
- Rice weevil—most destructive to whole grain and macaroni.

6-12. *Dried fruit and vegetable pests.* Dried fruit and vegetable pests include the following:

- Cigarette beetle—found in dried fruits or tobacco products.
- Bean weevil.

These are only a few of the most common species of economic pests. For more complete information on these and other economic pests, consult a good entomology text, such as *Insects, the Yearbook of Agriculture,* U.S. Dept. of Agriculture, available through the U.S. Government Printing Office; or AFM 91-16, *Military Entomology Operational Handbook.*

6-13. In addition to these economic pests, two families of arthropods are of concern because of

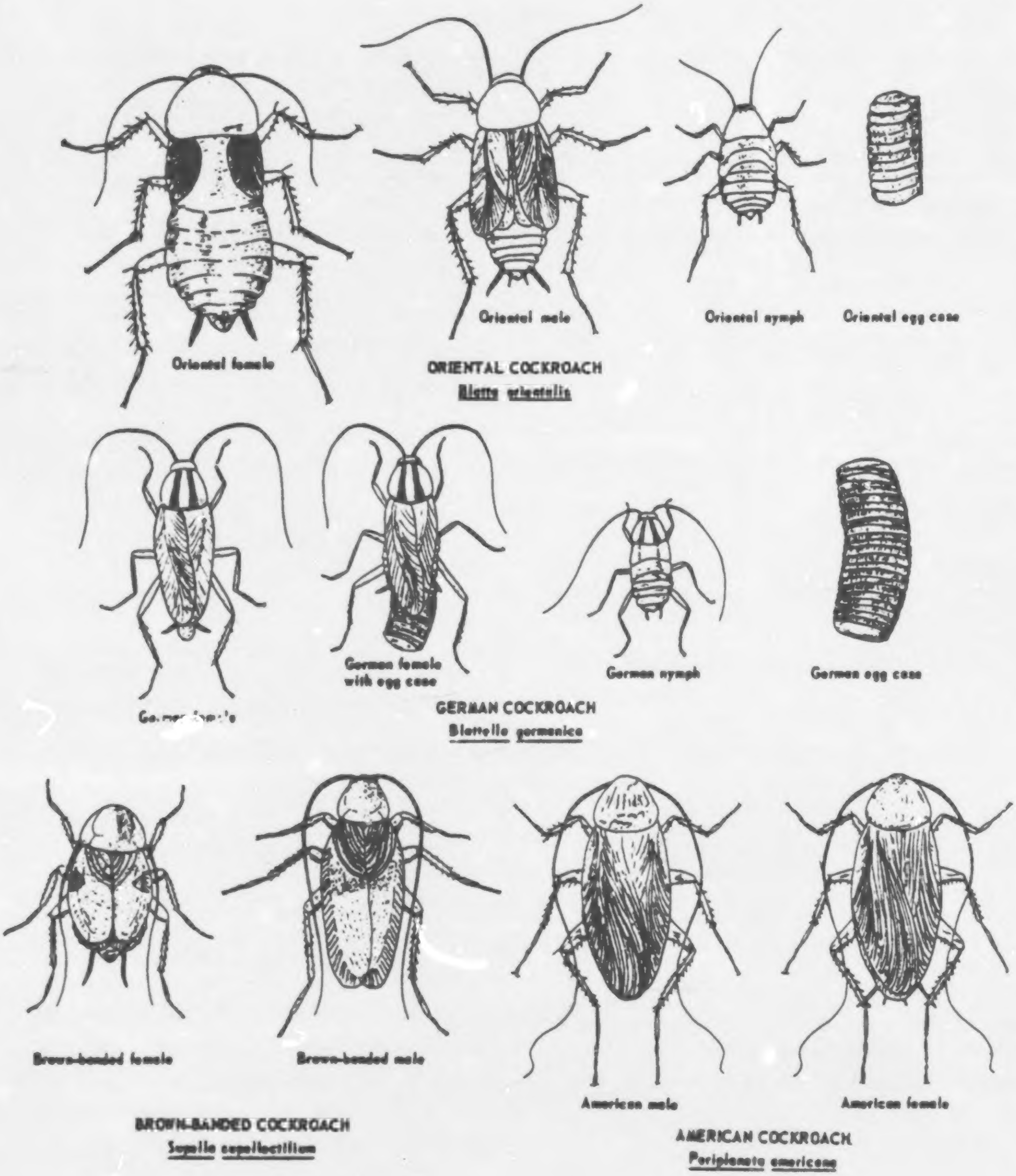
Oriental female
Oriental male
Oriental nymph
Oriental egg case
ORIENTAL COCKROACH
Blatta orientalis
German female
German female with egg case
German nymph
German egg case
GERMAN COCKROACH
Blattella germanica
Brown-banded female
Brown-banded male
BROWN-BANDED COCKROACH
Supella supellectilium
American male
American female
AMERICAN COCKROACH
Periplaneta americana

Figure 1. Common species of cockroaches.

their attraction to food. They not only are pests, but are likely to spread many types of disease through mechanical transmission. These are the cockroaches and the housefly.

6-14. *Cockroaches*. Cockroaches are one of the oldest groups of insects. Specimens have been found which were estimated to be 200 to 500 million years old. These insects are among the most persistent pests of man. They are highly adaptable and can fit themselves into almost any living condition.

6-15. Cockroaches are frequently found associated with stored foods, or with food that is in actual use. Cockroaches eat a fair amount of such food; they may, in heavy infestations, impart a nauseous odor to it as well. Many disease organisms have been isolated from the feet and legs of cockroaches. Cockroaches damage bookbindings, feeding on the starchy paste material with which such bindings are impregnated. Some damage to clothing may result from the inroads of cockroaches, but this is principally due to feeding on spots of spilled food, rather than on the cloth itself.

6-16. Some of the common species of cockroaches are shown in figure 1. Cockroaches undergo gradual metamorphosis, and progress through nymphal stages to the adult. There are about 55 species in the United States, but only a few are common pests. All of these have wings in the adult stage, except the female Oriental cockroach. The eggs are laid in capsules. These may be carried about, protruding from the abdomen of the female, or they may be glued to the underside of drawers and cabinets. The eggs in these capsules hatch and very small nymphs emerge. These nymphal forms have the same habits that characterize the adults, except that they do not fly and, of course, cannot reproduce.

6-17. The outdoor species of cockroaches normally live in piles of trash, under the bark of trees, and in dark places under houses. The species which are of most importance in buildings are essentially nocturnal, but may be seen during the daylight hours. They frequent various parts of buildings, being limited in most cases to the lower floors or basements where there is adequate moisture. They hide in cracks and crevices, in cabinets and storage areas, and in the spaces between walls. When disturbed, cockroaches will run very rapidly to a sheltered area and can disappear very quickly. The simplest method of making inspections for cockroaches is to walk quietly into a kitchen or storage area at night and suddenly flood the area with light. They may also be found by examining cracks and crevices, areas behind door facings, and openings through the walls for steam pipes.

6-18. Cockroaches usually enter buildings in containers brought in from other areas. They may also enter through cracks in walls, through attics and basements, or along pipes from other buildings which are heavily infested. Inspection of all incoming material will help prevent entry of these pests. However, since egg capsules may be attached to one can in the center of a carton, it is often impossible to make adequate inspections. If all cracks passing through walls or leading to areas behind baseboards and door frames are filled with putty or plaster and if all water, steam, and electrical pipes are given special attention so that there are no openings around them, invasion of cockroaches can be cut to a minimum. Thorough cleaning to remove food will also help control the numbers present. Cockroaches will not normally stay where there is no suitable hiding place or food.

6-19. Control of cockroaches in established infestations requires the use of chemicals as well as excellent sanitary practices. Insecticides are applied as liquids or dusts. Residuals are applied to surfaces where roaches will run, and to harborage sites where they remain for longer periods. In some unusual cases, poisoned baits are useful. Aerosols are sometimes used in conjunction with other treatment, but are unsuitable when used alone.

6-20. Roach control is not obtained with aerosols alone. These cause a rapid knock-down, but the roaches will revive. Aerosols are used to irritate and stimulate roaches. This is an effective survey technique to flush them from hiding. In conjunction with residuals, aerosol may also cause the roaches to run over areas where residuals are present. Aerosols *will* kill roaches in sewer lines. The confined atmosphere of sewers makes the thermal fogs, mists, and aerosols effective.

6-21. Residual insecticides in dust and liquid form are used for cockroach control. In some locations, some roaches have developed resistance to certain chemicals. When this occurs, other material must be used. A combination of dust following spray treatment will give much longer and more effective residual control than dust or spray used alone. Roaches have developed a general widespread resistance to the chlorinated hydrocarbon insecticides. Therefore, diazinon, DDVP, or Malathion sprays, and diazinon dust are normally the insecticides used.

6-22. *The housefly*. This common pest is a mechanical transmitter of many filth-borne diseases, such as typhoid, cholera, and dysenteries. The adult is dark gray with four black stripes on its thorax. It measures 6 to 7 mm. in length. The mouth is not adapted for biting, only for sucking; therefore, all its food must be in liquid form.

6-23. The female housefly lays about 100 eggs in a mass on various animal manures, garbage, or other refuse. The eggs usually hatch within 24 hours into small white larvae, referred to as maggots. The larval stage lasts from 5 to 8 days and the larva burrows into the ground a few inches before pupating. The pupa lasts about 5 days, and the adult fly must then make its way up out of the ground before the wings harden. The entire life cycle may take 8 to 20 days; however, under optimum conditions of temperature and moisture, this period may be even less.

6-24. There are several means by which flies transmit disease. Examination of the foot of the housefly under a microscope reveals a hairy appendage which is well-suited to picking up material on which the fly walks. Since breeding occurs in various manures, you can see that if human manure is the breeding matter, pathogenic organisms present can be picked up. If a fly then lands on a piece of bread, transfer of the organisms may occur.

6-25. A second method of disease transmission occurs during feeding. As previously mentioned, flies have only sucking mouth parts. They do not feed on solid material. Let's assume a fly lands on a piece of bread. When feeding, the fly forces saliva from its mouth onto the bread. This dissolves the surface of the bread, which can then be sucked up as liquid. Vomitus is also forced up and ejected during this process. Any viable organisms previously ingested by the fly, may be added to the bread.

6-26. The fly also has a third method by which it may contaminate man's food. It has been proved that enteric diseases taken up by the housefly are still viable when defecated by the same fly. Since the fly defecates at the same time that it feeds, transmission of disease may also occur in this way.

6-27. Prevention of entry into buildings is one of the best-known and widely used controls. Screening over windows and doors is the oldest of these methods. Where screens are not practical or where they are ineffective due to traffic, air screens should be installed. The air current must be of sufficient force to deter flies from entering through the openings. Screening, however, should not be used instead of preventive controls. The best measures for control of houseflies are those which are directed at the cleaning up or removal of breeding sites.

6-28. Sewage control is usually not a problem on most bases, as far as fly breeding is concerned. However, garbage control is a problem on all airbases. In addition to the final disposal of material, garbage must be properly handled by civil engineering personnel in order to prevent fly breeding. Since, in some areas, flies can breed quite rapidly, garbage from mess halls and quarters areas should be removed at least once weekly. Daily disposal is preferred. Garbage cans should be kept clean. This will help considerably in the control of flies. Spilled garbage, particularly liquid and semiliquid wastes will soak into the ground and allow breeding around garbage cans. Cans should be kept closed with a tight-fitting lid to prevent access of flies.

6-29. Any normal-size issue screening will prevent the entrance of houseflies, but these screens must be kept in good condition and must be tight-fitting, and screen doors should swing outward, to push away flies which may be clinging to them. An inward-swinging screen door may admit flies that are resting on it each time it is opened.

6-30. In many cases, the source of houseflies is not located on the base, but on nearby farms and in open privies. Control of off-base breeding must be coordinated with the local Health Department, since the Air Force has no authority on private property.

6-31. The adult fly, after emerging from the pupa, must force its way upward through the surface of the breeding material. This fact can be used in some cases to effect a measure of control. In areas where red clay soil predominates, sprinkling of the earth in the morning and then allowing it to harden under a hot sun has been used as a method of fly control. Similarly, the soaking of soil around privies with a chemical insecticide may be of some help, but the addition of insecticides to the contents of the privy is not recommended. Chemical insecticides may reduce the natural bacterial activity which occurs in a privy. Houseflies are attracted primarily to vertical surfaces such as light cords, and light pull chains. They also rest on walls and on the ceiling. This characteristic makes possible control through use of fly cords, fly tapes, and residual sprays. However, fly tapes and cords are discouraged, because if proper steps are taken to prevent breeding, fly tapes and cords will be unnecessary.

6-32. One pair of houseflies in the early spring could produce billions of flies by late fall, if all of their young lived. It is, therefore, important to kill as many as possible early in the season. A good early-season fly control program will result in very few flies all year long. In discussing the importance of a fly-control program with troops, effective cooperation can be obtained if the filthy habits of the fly are stressed. A good point to make is that any time a fly is seen on food it is well to remember where this fly probably fed last. This usually results in an increased demand for fly swatters at supply and incidentally, the fly swatter is still an excellent tool for individual fly control.

6-33. *Rodents.* Rats and mice have followed man to most of the areas he has settled. Man's indifference and carelessness in handling foodstuff and refuse have fostered populations of rats and mice in such proximity to his home and work that they are called "domestic" rodents. As a result of this relationship, man suffers from rat bites and rodent-borne diseases. Rodents are reservoirs for

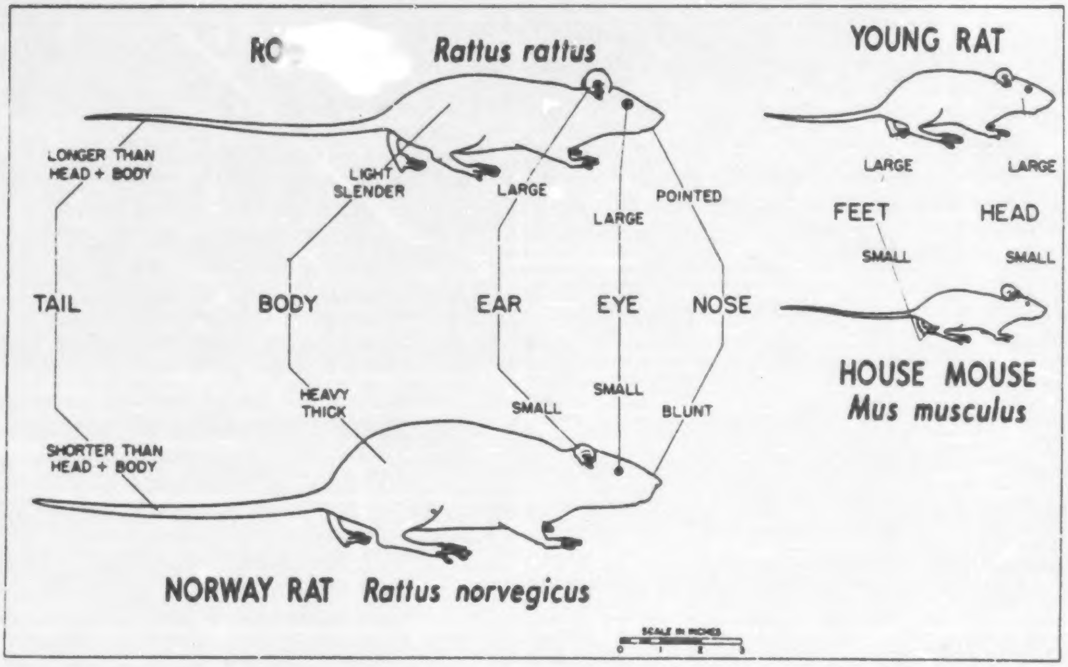
RO
Rattus rattus
YOUNG RAT
LONGER THAN HEAD + BODY
LIGHT SLENDER
LARGE
LARGE
POINTED
LARGE
LARGE
FEET
HEAD
SMALL
SMALL
TAIL
BODY
EAR
EYE
NOSE
HOUSE MOUSE
Mus musculus
HEAVY THICK
SMALL
SMALL
BLUNT
SHORTER THAN HEAD + BODY
NORWAY RAT Rattus norvegicus
SCALE IN INCHES
0 1 2 3

Figure 2. Common rodents.

diseases that have killed millions of people. These include murine typhus fever, plague, leptospirosis (Weil's disease), rat-bite fever, salmonellosis, and rickettsialpox.

6-34. Rats and mice common in the United States are shown and compared in figure 2. Refer to this figure as you read the following descriptions of rats and mice.

6-35. The *Norway rat (Rattus norvegicus)* is predominantly a burrowing rodent. It is the most common and largest of the domestic rats. It is found generally throughout the United States and the temperate regions of the world. Some of the characteristics of this rodent are:

a. Harborage: ground level, burrows in ground and under foundations of buildings and in rubbish dumps.
b. Range: frequently 100 to 150 feet.
c. Food and water: omnivorous; garbage, meat, fish and cereal baits well accepted; daily requirement ¾ to 1 ounce of dry food, ½ to 1 ounce of water.

6-36. The *roof rat (Rattus rattus, Rattus rattus Alexandrinics,* or *Rattus rattus frugivorour)* is an agile climber. It is a middle-sized rodent, confined largely to the south and to the Pacific coast in the United States. It is found most abundantly in the tropical or temperate regions, but is rare or absent in the colder portions of the world. Characteristics are:

a. Harborage: above ground level, indoors in attics, between walls, and in enclosed spaces of cabinets and shelving; outdoors in trees and dense vine growth.
b. Range: frequently 100 to 150 feet.
c. Food and water: omnivorous; vegetables, fruits and cereal grains preferred; daily requirement ½ to 1 ounce of dry food and up to 1 ounce of water.

6-37. The *house mouse (Mus musculus)* is the smallest of the domestic rodents. It is widespread and abundant throughout the United States. It is found from the tropics to the Arctic region throughout the world. Some of its characteristics are:

a. Harborage: any convenient space in walls, cabinets or furniture.
b. Range: frequently 10 to 30 feet.
c. Food and water: omnivorous; cereal grains preferred; mouse is a nibbler, daily requirement 1/10 ounce dry food, requiring little water (1/20 ounce per drink).

6-38. Rats and mice are habitually nocturnal and secretive. They are rarely seen except when heavy infestations are encountered. Therefore, it is necessary to interpret signs of their activities properly in order to plan control work. These signs are found in secluded places such as along walls, under pipes or rubbish, and behind or under boxes, boards, and thick vegetation. From rat signs, one can tell the species concerned and whether a rodent infestation is current or old, heavy or light.

6-39. Feces, if fresh, will be soft, shiny, and dark. In a few days they become dry and hard. Old droppings are dull and grayish. They crumble when pressed with a stick.

6-40. Rats habitually use the same runways between food, water, and harborage. Because of the keenly developed sense of touch in their whiskers and in specialized hairs along the body, rats prefer continual body contact with at least one vertical surface, such as a fence or wall. Outdoors these runways are narrow pathways of beaten earth swept clear of debris. Indoors, greasy runways are found along walls, steps, and rafters. Undisturbed cobwebs and dust in a runway indicate that the runway is not in use.

6-41. Along regularly traveled runways a dark, greasy mark usually forms from contact with the rodent's body. Fresh marks are soft and greasy. They will smear if rubbed. With age, the grease dries, gathers dust, and will flake off when scratched with a fingernail. Norway rat rubmarks are most commonly found along walls near ground or floor level. Roof rat rubmarks are most commonly located overhead as swing marks beneath beams or rafters where they connect to the walls. Mice seldom leave detectable rubmarks.

6-42. The Norway rat prefers burrows for nesting and harborage; the roof rat burrows only occasionally. Burrows are found in earth banks, along walls, under rubbish, under concrete slabs, and in similar places. If being used, the burrow entrance will be free of cobwebs and dust. Fresh rubmarks on hard-packed soil at the opening indicate a well-established and presently used burrow. Fresh food fragments or freshly removed earth at the burrow entrances also indicate current use by rats.

6-43. Rats must gnaw daily to keep their teeth short enough to use. They gnaw to gain entrance to obtain food. When fresh, gnawings are light in color and show distinct teeth marks. Small chips of wood or other materials indicate recent gnawing. With age, the wood around gnawed holes becomes dark and smooth from frequent contact with the rodent's body.

6-44. Fresh tracks appear sharp and distinct. Old tracks are covered with dust and are less distinct. The tracks of the 5-toed rear paws are more commonly observed than are the 4-toed front paws, but both may be present. Smooth tracking patches of any dust material such as flour or talc, placed along runways, are of value in checking for rodent activity. To see tracks in dust, hold a flashlight at an angle to the tracks and it will cast distinct shadows.

6-45. The best control for rodents, as for insects, is prevention. Physical measures and sanitation practices are foremost in this area. The best preventive measures include:

- Prevention of entry into buildings.
- Frequent and thorough cleanup of trash and debris.
- Proper waste disposal.
- Proper food storage.
- Elimination of food sources.
- Elimination of harborage.

6-46. Floors should be swept frequently to remove rodent food and to permit ready detection of fresh rodent signs. A white band, 6 inches wide, painted along the floor next to walls in food-handling locations speeds discovery of droppings, tracks, and other signs that indicate the presence of rodents.

6-47. Thorough inspections should be regularly scheduled to detect any new evidence of rodent infestation. Effective and permanent control of rats and mice can be attained only through a *continuous sanitation* program.

6-48. Established rodent populations can be eliminated by combining the sanitation methods with a killing program. Killing methods are most effective:

a. Before sanitation or cleanup programs are begun. This will prevent mass movement and spread of rodents.

b. After dusting with an approved pesticide for flea control. This is to suppress plague and murine typhus by reducing rodent populations. If rodents are killed and fleas are not, fleas will leave the dead rodents and may cause widespread disease outbreaks.

c. After vent stoppage work to eradicate rodents in buildings.

6-49. Rat killing as well as insect killing, without good sanitation, is ineffective for several reasons. Insects and rodents rapidly regain the original population level through their high birth rate and survival of young. The cost of labor and materials in a continuous killing program is high. Bait-shyness and insecticide resistance may develop from continued use of most poisons. For these reasons, it is a waste of your time and effort to have a killing program which is not supplemented with a sanitation program.

MODIFICATIONS

Pgs 21 - 26 of this publication has (have) been deleted in adapting this material for inclusion in the "Trial Implementation of a Model System to Provide Military Curriculum Materials for Use in Vocational and Technical Education." Deleted material involves extensive use of military forms, procedures, systems, etc. and was not considered appropriate for use in vocational and technical education.

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APPENDIXES

Appendix A. Food Plant Sanitary Compliance Checklist
Appendix B. Tests for Cleanliness of Surfaces

APPENDIX A

Food Plant Sanitary Compliance Checklist

Sanitary Inspection of ______________________________
(Name of Plant)

____
(Address) (Phone Number)

Inspection of this plant was accomplished on ______________
(Date)

by ______________________________
(Inspector)

Plant is owned by ______________________________

______________________ and the inspector was accompanied

on the inspection by ______________________________
(Name and Title)

This plant produces ______________________________
(General Types of Items)

Sanitary Defects (1)	Assigned Defect Points (2)	Inspr's Defect Points (3)
1. PREMISES		
A. Not clean	3	
B. Not well-drained	3	
C. Surroundings not free from nuisances and sources of contamination	5	
2. RAW MATERIALS		
A. Not free from adulteration	Critical	
B. Shows evidence of insanitary conditions or deterioration	5	
C. Not processed, stored, or delivered under sanitary conditions	5	
D. Packaging materials not protected by sanitary boxes, cartons, or other means	4	
3. CONSTRUCTION OF BUILDINGS		
A. Design, materials, or construction of walls, floors, or ceilings prevent their maintenance in a sanitary manner	4	
B. Exterior openings not clean and in good repair	4	
C. Exterior openings, where practicable, not equipped with screens or other effective means to prevent the entrance of insects, rodents, and other animals	4	
D. Insect and rodent control not effective in those areas where screening of exterior openings is impracticable	4	
E. Screen doors not outward opening and self-closing	3	
F. Processing area opens directly into living quarters, garage, or heavy maintenance shop	4	

Sanitary Defects (1)	Assigned Defect Points (2)	Inspr's Defect Points (3)
4. LIGHTING		
A. Insufficient lighting	4	
B. Lights in processing areas not equipped with protective shields when required	5	
5. VENTILATION		
A. Presence of objectionable odors	5	
B. Presence of mold in processing or storage areas	3	
C. Accumulation of condensates in processing or storage areas	5	
6. WATER SUPPLY		
A. Inadequate in quantity	5	
B. Not easily accessible	4	
C. Potability certificate not current or not available or water supply found to be nonpotable	Critical	
D. Cross-connection exists between safe water and unsafe water supply or sewage disposal system	Critical	
E. Nonpotable water outlets not identified	Critical	
7. ICE		
A. Not made from water that is of a safe sanitary quality, approved by State or local health authority	Critical	
B. Not manufactured, handled, stored, or used in a sanitary manner	5	
8. DISPOSAL OF WASTES		
A. Liquid wastes not disposed of in a sanitary manner	5	
B. Floor drains not functional nor properly trapped	3	
C. Dry wastes not collected in suitable containers conveniently located throughout the plant	3	
D. Product waste not collected in suitable containers which are covered when not in use	3	
E. All waste not collected and disposed of at frequent intervals or in a sanitary manner	4	
9. TOILET, DRESSING ROOM, AND HANDWASHING FACILITIES		
A. Sufficient number of toilets or privies not provided	Critical	
B. Toilet rooms not conveniently located nor constructed of materials that are easily and satisfactorily cleaned	4	
C. Toilet rooms open directly into processing area	5	
D. Doors not self-closing and tight-fitting	3	
E. Absence of sign directing employees to wash hands	3	
F. Privies not separate from processing building	Critical	
G. Privies not of sanitary type, location, and construction	5	
H. Absence of hot or cold water, soap, or hand-drying facilities	5	
I. Wastes accessible to insects	5	
J. Toilet rooms not separately vented to the outside	5	
10. CONSTRUCTION AND REPAIR OF EQUIPMENT		
A. Product-contact surfaces of all equipment not constructed of nontoxic material	Critical	
B. Design of equipment is such that it cannot be readily cleaned and effectively sanitized	5	
C. Equipment not in good repair	5	
D. Not constructed so that all product-contact surfaces are accessible for cleaning, maintenance, and inspection	5	
11. CLEANING AND SANITIZING TREATMENT		
A. Product-contact surfaces of equipment, containers, and utensils not thoroughly cleaned after use	5	
B. Product-contact surfaces not sanitized prior to each usage	5	

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* *NOTE TO STUDENT:* Do not count items 7A, 7B, or 9G when adding column 2.

Sanitary Defects (1)	Assigned Defect Points (2)	Inspr's Defect Points (3)
C. Chemicals used in cleaning and sanitizing treatments not properly labeled or stored	5	
D. Rooms and areas used for receiving, processing, and storing of raw materials and finished product not maintained in a clean, sanitary manner	4	
12. METHODS		
A. Methods permit contamination of product	Critical	
B. Methods permit deterioration of product	5	
13. SANITARY CONTROLS		
Records of examinations and tests of raw materials and finished products not available	5	
14. CONTROL OF INSECTS, BIRDS, AND ANIMALS		
A. Rodent harborages or insect-breeding places present	4	
B. Insects, birds, or animals present in the plant	5	
C. Insecticides or rodenticides are handled so as to contaminate the product	Critical	
15. COOLING AND REFRIGERATION FACILITIES		
A. Facilities do not adequately cool nor maintain the raw materials or finished product in a refrigerated or frozen state as required	5	
B. Design of equipment permits contamination or adulteration of product	Critical	
C. Acceptable thermometer not present in warmest area	3	
16. STORAGE FACILITIES		
A. Storing methods do not minimize deterioration nor contamination	5	
B. Storage facilities not clean, sanitary, or in good repair	3	
C. Shelves, cabinets, or dunnage not used where necessary to prevent contamination or deterioration	5	
17. VEHICLES AND TRANSPORTATION FACILITIES		
A. Not constructed or operated to protect contents from contamination or deterioration	Critical	
B. Not properly maintained or not clean	3	
18. PERSONNEL		
A. Not free of communicable or infectious diseases	Critical	
B. Not free of infected cuts, open sores, or other lesions on exposed parts of the body	Critical	
C. Not wearing clean outer clothing or head covering	3	
D. Eating, smoking, chewing tobacco, or expectorating in product-handling areas	3	
E. When required, records of preemployment or periodical physical examinations not on file	4	
SCORE		

REMARKS ____________________

RECOMMENDATIONS: ____________________

(Inspector's Signature and Title)

APPENDIX B

Tests for Cleanliness of Surfaces

Contents

Finger-Plate Culture Technique

The Rinse Test

The Swab Test

Contact Plate Test

Ultraviolet Test for Residual Soil Film

Other Tests

Tests for Evaluation of Dishwashing Machines

Finger-Plate Culture Technique

1. *Principle:*

The "finger-plate" culture technique is a simple procedure for detection of coliform bacteria, especially *Escherichia coli* strains on the hands of Food Service personnel. Since the presence of these organisms is indicative of fecal contamination, the technique can be effectively used to determine whether a given foodhandler is washing his hands after defecation. Although an individual may be a carrier of *Salmonella* or *Shigella sp.*, the possibilities of spreading these organisms are reduced or precluded if the hands are kept clean. For this reason, the "finger-plate" culture technique serves as a valuable preventive medicine tool.

2. *Materials:*

Eosin Methylene Blue (EMB) agar prepared in standard petri dishes or 2-ounce ointment tins. For medium preparation, see *DIFCO Manual*, 9th Ed., 1953 (Difco Laboratories Inc., Detroit, Michigan).

3. *Procedure:*

"Finger-plate" cultures are taken by having the foodhandler gently press the fingers of each hand on the surface of EMB agar. The medium is then incubated at 37° C. for 24 to 48 hours. Following incubation, frank evidence of fecal contamination is the presence of large, smooth, glistening colonies with maroon, purple, or black centers and a greenish-yellow metallic sheen. Metallic sheening is usually evident both on the colonies as well as on the surface of the surrounding medium. Such growth is typical for *Escherichia coli;* and with little experience, nonlaboratory-trained individuals are able to recognize positive results from this organism. Greater sensitivity may be added to the technique by having all "finger-plate" cultures containing growth of colored colonies with no metallic sheening examined by experienced laboratory personnel, since certain *Escherichia coli* strains occasionally fail to develop a metallic sheen on EMB agar. It is emphasized that only the cultures containing the characteristic colored colonies with metallic sheening be regarded as "positive" for fecal bacteria unless further laboratory study reveals the presence of *Escherichia coli.*

4. *Possible Errors:*

Certain lots of EMB agar fail to yield typical metallic sheening of *E. coli.* Therefore, a control culture known to produce sheening should be inoculated to a plate from each batch of EMB agar used and incubated along with the finger culture. *Citrobacter (Escherichia) freundi* strains are rarely encountered on the fingers of foodhandler. Since these organisms may originate from fecal material or soil, their presence is still indicative of improper handwashing. When the true identity of a sheening colony is in doubt, *E. coli* or *C. freundi* cultures can be verified by subculture to triple sugar iron agar and IMVIC media. Positive results will be high when such cultures are first taken, but as health education and supervision increase, the percentage of positive handlers should be low. Chronic repeaters will need additional supervision or training and may even need transfer.

THE RINSE TEST

1. *Materials Needed:*

a. Transfer pipettes, sterile — delivery 10 ml.
b. Dilution pipettes, sterile — delivery 1.1 ml.
c. Petri dishes, sterile.
d. Plate count agar; omit addition of skim milk.
e. Tap or buffered distilled water, nontoxic, sterile (tubed in 20 ml. amounts).
f. Sodium thiosulfate solution, approximately 0.1*N* which should be incorporated in buffered rinse medium if a chlorine disinfectant was used on item to be tested. Not necessary if nutrient broth is used.
g. Hypodermic syringe and needle, sterile — delivery 20 ml. (optional).

2. *Procedure:*

a. Introduce 20 ml. of sterile tap or buffered distilled water into bottle to be tested.
b. Cap bottle aseptically with sterile cap.
c. Grasp bottle by neck and while holding upright, swing it 25 times in a small circle to rinse bottle thoroughly.
d. Follow by holding bottle horizontally and vigorously shake lengthwise 25 times, each shake being a to-and-return thrust of almost 8 inches. Turn bottle slightly at end of each shake and make eight complete rotations of bottle during shaking operation to rinse sidewalls thoroughly.
e. Plate immediately, if rinse operation is performed in the laboratory. If samples are to be transferred to a laboratory, transfer rinse solution to sterile containers aseptically and keep at 32° F. to 40° F. until plated.
f. Pour appropriate controls (agar, petri dish, pipette, and rinse solution).

3. *Plating:*

a. If contamination is believed to be light:
(1) Distribute 10 ml. of the 20 ml. used for the rinse test about equally among three sterile petri dishes and incubate for 48 hours at 35° C.
(2) To obtain total count, multiply the sum of the number of colonies on the three plates receiving 10 ml. of rinse solution by 2, which will give the estimated number of colonies per bottle.

b. If contamination is believed to be heavy:

(1) Transfer 1 ml. of rinse solution to each of two petri dishes.

(2) To obtain total count, multiply the *average* number of colonies on the plates by 20, which will give the *estimated number of colonies per bottle.*

c. If desired, with contamination considered great enough to result in more than 300 colonies per plate, 0.1- and 1.0-ml. portions of the rinse solution may be plated directly. In such instances, if the 30-to-300-colony range is obtained on the 0.1-ml. plate, multiply the count by 200. If the plate counted is the 1.0-ml. plating, then the count times 20 will result in the estimated number of colonies per bottle.

d. When information on high-count bottles is required, dilutions may be made of the rinse solution. Here the count per plate is multiplied by the dilution, followed by multiplication by 20, to obtain the estimated number of colonies per bottle.

4. *Important Consideration:*

a. If chlorine or iodine disinfection of bottles is practiced, a neutralizer such as sodium thiosulfate, 0.1*N*, contained in the rinse solution should be used in order to prevent the continued germicidal action of residual chlorine in the test bottle on the organisms rinsed off the container by the rinse solution, thereby giving a false indication of the bacterial condition of the container. Not necessary if nutrient broth or skimmed milk is used as rinse medium.

b. If quaternary disinfection is practiced, an inactivator such as sodium napthuride or Tamol N should be used in the rinse solution in a 200-p.p.m. concentration, followed by plating the test rinse solution in tryptose glucose extract Tween (1 percent) — Asolectin agar (100 p.p.m.) in order to minimize or eliminate bacteriostatic carry-over of quaternary.

5. *Interpretation of Results:*

Colony estimates by the agar plate method (rinse test) not exceeding:

Per quart bottle	1000
Per pint bottle	500
Per one-half pint bottle	250

are considered satisfactory.

These standards are derived on an allowable basis of one colony per 1 ml. capacity of the container and are applicable to all rinse test methods involving the rinsing of closed containers.

THE SWAB TEST

This test is adaptable to equipment where size and irregularity of surface will not permit satisfactory use of either rinse or contact plate methods. However, it may be applied to milk cans and other similar equipment. It is the method generally used in determining food utensil sanitization.

1. *Materials Needed:*

a. Sterile petri dishes.
b. Sterile 1 ml. pipettes.
c. Plate count agar (omit skim milk).
d. Sterile forceps or scissors.

e. Sterile cotton swabs (nonabsorbent cotton) on standard wooden applicator sticks (or sterile alginate swabs) in cotton-plugged test tubes.

f. Sterile containers, screw-cap swab bottles, size 23 x 70 mm. or 16 x 100 mm., with 4 ml. buffered distilled water.

g. Buffered distilled water (See *Standard Methods for Examination of Dairy Products*). (If chlorine, iodine or quaternary disinfection is practiced, use appropriate inactivator and proceed in accordance with instructions under rinse test section above.)

h. Use sufficient sterile buffered distilled water solution that will provide exactly 1.0 ml. for each utensil to be examined by swab technique. Thus, for successive swabbings of four utensils, using one swab and diluent container, use 4 ml. of rinse solution.

2. *Collecting Samples:*

a. Utensils to be examined shall include at least glasses, cups, and spoons, and four of each should be selected at random from the shelves or other places where *clean* utensils are stored.

b. In direct checks of dishwashing methods, select utensils from those recently washed. Prevent contamination by handling during sampling.

c. Use one swab for each group of four similar utensils.

3. *Swabbing Procedures:*

a. Dip a sterile swab in dilution water and squeeze it against the inside of the container to remove excess water, leaving the swab moist but not wet.

b. Rub the swab slowly and firmly three times over the significant surfaces of four utensils, *reversing* the direction each time. Significant surfaces of utensils consist of:

(1) The upper ½ inch of the inner and outer rims of cups and glasses.

(2) Entire inner and outer surfaces of the bowls of spoons.

(3) Entire inner and outer surfaces of the tines of forks.

(4) Inner surfaces of plates—swab three times, reversing the direction of each stroke. Swab across each of two diameters at right angles to each other.

(5) Inner surfaces of bowls—swab three times, reversing the direction of each stroke around the inner surface at a level at which the swab will hug the surface of the bowl about half-way between bottom of bowl and rim.

c. After swabbing each individual similar utensil, return the swab to the container of dilution water, rotate (whip-rinse) the swab in the dilution water, and press out the excess water against the inside of the container before swabbing the next of the four utensils in the group.

d. On completion of the swabbing of the group of utensils, break off the swab in the container or dilution water under aseptic conditions. Use a new swab container for the next group of utensils.

e. Keep containers iced while intransit to the laboratory. Plate the dilution water samples preferably within 4 hours of swabbing, but when this cannot be done, samples must be properly refrigerated and analyzed within 24 hours of swabbing.

4. *Plating Procedure:*

a. Shake the swab container rapidly, making 50 round-trip excursions of 4 to 6 inches with the container in one hand, striking the palm of the other hand at the end of each cycle and completing the whole in about 10 seconds. NOTE: Groups of samples may be shaken in test tube, holding blocks with similar stroke, speed, and abrupt ending of strokes. Shaking machines may be used for the time interval found to disintegrate the cotton swab in a manner equivalent to the prescribed hand method.

b. Transfer 1 ml. of the dilution water to a sterile petri dish.

c. Add approximately 10 ml. of melted standard plate count agar (without skim milk), mix and incubate for 48 hours at 37° C. and count as in making standard plate count.

d. Make appropriate controls (agar, petri dish, dilution water, pipette).

e. Report the count as the average plate count of organisms removed per utensil surface examined.

Example: 4 glasses swabbed.
1 ml. of the 4-ml. dilution water plates.
60 colonies are counted after incubation.
Record average plate count per glass surface as 60.

f. If, under the same conditions, the 4 ml. are plated by distributing equal portions into each of three petri dishes, the sum of the counts on each plate divided by 4 would give the average plate count per glass surface.

5. *Interpretation:*

The most commonly accepted standard is not more than 100 colonies per utensil. The most commonly accepted basis for this is 100 organisms per 8 square inches swabbed, or 12½ organisms per square inch.

CONTACT PLATE TEST

1. *Materials Needed:*

a. Sterile disposable contact plates, often called "Rodac" plates, available from Falcon Plastics, 5500 W. 83rd St., Los Angeles 45, California, and some other laboratory equipment suppliers. This plate differs from petri plates in its shape, as seen below.

b. Transfer pipettes, sterile, 10 ml.

c. Plate count agar, omit addition of milk.

2. *Procedure:*

a. Carefully and aseptically introduce enough sterile agar (usually 15.7 ml.) into the sterile plate so the agar meniscus is slightly raised above the plate rim. Allow to solidify *without* moving.

b. To test a surface, remove the lid, invert plate, and gently press the raised agar surface onto test site. Carefully lift the plate after several seconds and replace lid.

c. Incubate, normally, for 48 hours at 32° C. or 35°C.

3. *Interpretation of Results:*

a. Number of colonies gives a direct count of the surface area tested for the 4 square inches of the plate surface.

b. Divide count by 4 and apply available standards for count per square inch.

ULTRAVIOLET TEST FOR RESIDUAL SOIL FILM

1. This is a very simple and accurate test, requiring only a fluorochrome dye (any soluble color) and an ultraviolet light (Woods lamp).

2. When surfaces, whether dishes or steel tables, are exposed to a solution containing dye, the fluorochrome absorbs to any porous surface, usually the soil, and then fluoresces under ultraviolet light.

3. Mix a 1:1000 solution of dye in water. The dye may be mixed directly into the wash tank of a dishwashing machine to check its efficiency, or may be

mixed in a container and the small items to be tested dipped therein, or the solution may be used as a spray for surfaces of large items.

4. *Procedure:*

a. Whether dipped, sprayed, or washed, the test items should be exposed to the dye solution for 30 seconds.

b. Then rinse *well* in running cold or warm water for several minutes. A machine's rinse cycle will do this automatically.

c. Examine under ultraviolet light in dark or semidark room.

5. *Interpretation:*

a. Large spots *usually* indicate poor washing.

b. Small spots *usually* indicate poor rinsing.

c. Diffuse fluorescence indicates carryover of dye into rinse tank (which is a discrepancy within the machine), a long-standing buildup of grime or minerals due to poor washing, or *extremely* inadequate washing.

6. *Discussion:*

a. If you have never performed this test, it would be wise to have a dry run, using a *spotlessly clean* item for a comparison.

b. Remember, porous surfaces such as aluminum, crazed china, dull plastics, etc., will pick up dye.

c. This is an excellent test for all utensils—but especially for sieves, colanders, beaters, grinders, pitchers, etc.

OTHER TESTS

1. *Safranin Dye Test:*

a. Make a powder mixture of 85 percent by weight talc (U.S.P., *not* face powder) and 15 percent by weight safranin and place in a salt shaker.

b. Dust onto *dry* test surfaces from a height of 2 inches.

c. Rinse the surface with cold water until no red color is rinsing off.

d. Organic matter, mainly grease, will be stained a deep red due to the adsorption of the talc onto the surface, but water spots will not be affected.

2. *Salt Test:*

Wet a dish in cool water and hold it so water can drain off for several seconds. Then sprinkle the surface with ordinary table salt. The surface of a clean dish will be evenly and completely wet with salt adhering overall. Areas with no salt adhering are areas of "water break" due to a grease film which the water was not able to "wet."

3. *Test for Clean Glasses:*

a. Fill a glass with regular soda water. Any evidence of bubbles clinging to the sides or bottom indicates inadequate cleaning. A *clean* glass will show very little or no bubbles adhering anywhere. Try it sometime. Pour the soda from a clean glass into a dirty glass and observe bubbles reappear from what had looked like uncharged water.

b. Partially fill a glass with water and observe the meniscus. If it is perfectly smooth and even, the glass is clean; if it is slightly wavy, the glass is dirty. Pour the water out and water drops will cling to the dirty glass but not to the clean one.

4. *Tissue Test:*

Rub surface to be tested vigorously with *white* tissue, filter cloth, or cheese cloth and note whether the tissue remains spotlessly clean.

5. *Rinsability Tests* (to see if all detergent was rinsed off):

a. Add 2 drops isopropyl or methyl alcohol to surface and allow it to evaporate. If no white deposit forms, the rinsing was good.

b. Wet the surface to be tested with a small amount of distilled water and drop onto it 1 drop of phenophthalein. A change to any shade of red indicates alkalinity and, hence, poor removal of the detergent.

TESTS FOR EVALUATION OF DISHWASHING MACHINES

1. The following steps should be followed to periodically determine the efficiency of machine operation.

a. Determine that the dishes are clean (see previous tests).

b. Determine, using a calibrated maximum-registering mercury thermometer, the temperature of the water in the *wash* and *power* rinse of a multiple-tank machine by immersion in the water in the respective tank(s). Either recalibrate the thermometer provided on the machine or record the corrective differential for the thermometer in an appropriate place.

c. The temperature of the water is *extremely significant* in providing effective sanitizing of the dishes. Wash water temperature less than those prescribed will result in an ineffective sanitization of dishes even when the final rinse temperature is properly maintained. Sanitization results from the cumulative temperature effects of wash, power rinse (if applicable), and final rinse waters.

d. Remove from the inlet manifold the thermometer or sensing bulb used to indicate the temperature of the final rinse water. Check the removed thermometer or sensing element against a calibrated maximum registering mercury thermometer by immersing both in a container (glass, pan, or can) of hot water. The calibration should be conducted at approximately the use range (180° F.). Recalibrate the machine thermometer if possible or record differential correction. NOTE: The sensing bulbs in certain machines are of such construction or are so located that they cannot feasibly be removed. There are three accurate alternatives which will permit the determination of the final rinse-water temperature in such instances. They are as follows:

(1) The access plug, located in the final rinse line, which permits determination of the flow pressure may be removed and a maximum registering thermometer inserted in the opening by means of a compression-type connector. Operate the final rinse and recalibrate the machine or record the differential correction.

(2) Using a modified version of a standard capillary tube, dial-type thermometer (such as U.S. Gauge, Design 8000, range 100° F. to 220° F., with a preformed, coiled, test bulb, 3-foot system or capillary, available from: U.S. Gauge, Division of Ametack Industries, Sellersville, Pa.), place the bulb parallel to the direction of the rinse jets and ½ inch from the jets. Operate the final rinse from 10 to 15 seconds, record the temperature on both the calibrated test thermometer and the final rinse thermometer of the machine. Recalibrate the machine thermometer or record the differential correction. A 5° temperature variation may be expected between the water temperature at the water location on the machine and the water at the rinse jet, depending on the design and construction of the individual machine.

(3) Attach the "leads" (sensitive elements) of an electronic pyrometer to dishes and allow them to complete the dishwashing cycle, recording the tem-

peratures for each. If the dish surface temperature reaches 161° F., the final rinse temperature is satisfactory.

e. Check that all spray nozzles in the wash, power rinse, and final rinse spray arms are open and unobstructed.

f. Determine that the flow pressure of the final rinse supply line is 20 p.s.i. (15 to 30 p.s.i. range is permissible).

g. Operate the machine and determine the wash, power rinse, and final rinse temperatures (corrected), and time periods.

h. If the above six steps are taken for the wash, power rinse, and final rinse cycles, and if temperatures and time periods are being observed, it can then be reasonably assumed that adequate sanitization of dishes is being accomplished.

2. By allowing a maximum-registering thermometer to pass through a machine, you will receive a good "ball-park" figure on which to base judgments. Do not rely on its reading as *entirely* accurate, since most of these thermometers' response time is too slow to positively show the highest temperature experienced. Follow the steps in paragraph 1.*d,* (1) and (2), for accuracy. Remember, the dish surface temperature should reach 161° F., but the water *within* the rinse spray arm should be a minimum of 180° F., to assure the surface temperature of 161° F.

1-2

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WORKBOOK

SUPPORT OF THE AEROSPACE MEDICAL PROGRAM

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This workbook places the materials you need *where* you need them while you are studying. In it, you will find the Chapter Review Exercises and their answers, and the Volume Review Exercise. You can easily compare textual references with chapter exercise items without flipping pages back and forth in your text. You will not misplace any one of these essential study materials. You will have a single reference pamphlet in the proper sequence for learning.

These devices in your workbook are autoinstructional aids. They take the place of the teacher who would be directing your progress if you were in a classroom. The workbook puts these self-teachers into one booklet. If you will follow the study plan given in "Your Key to Career Development," which is in your course packet, you will be leading yourself by easily learned steps to mastery of your text.

If you have any questions which you cannot answer by referring to "Your Key to Career Development" or your course material, use ECI Form 17, Student Request for Assistance," identify yourself and your inquiry fully and send it to ECI.

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Volume Review Exercise

ECI Form No. 17

STUDY REFERENCE GUIDE

1. *Use this Guide as a Study Aid.* It emphasizes all important study areas of this volume.

2. *Use the Guide as you complete the Volume Review Exercise and for Review after Feedback on the Results.* After each item number on your VRE is a three digit number in parenthesis. That number corresponds to the Guide Number in this Study Reference Guide which shows you where the answer to that VRE item can be found in the text. When answering the items in your VRE, refer to the areas in the text indicated by these Guide Numbers. The VRE results will be sent to you on a postcard which will list the *actual VRE items you missed.* Go to your VRE booklet and locate the Guide Number for each item missed. List these Guide Numbers. Then go back to your textbook and carefully review the areas covered by these Guide Numbers. Review the entire VRE again before you take the closed-book Course Examination.

3. *Use the Guide for Follow-up after you complete the Course Examination.* The CE results will be sent to you on a postcard, which will indicate "Satisfactory" or "Unsatisfactory" completion. The card will list *Guide Numbers* relating to the questions missed. Locate the numbers in the Guide and draw a line under the Guide Number, topic, and reference. Review these areas to insure your mastery of the course.

Guide Numbers 500 through 507

Guide Number	
500	Introduction to Medical Aspects of Food Handling; Foodborne Illnesses; pages 1–4
501	Prevention of Foodborne Illness; pages 4–9
502	Food and Beverage Vending; Flight Feeding; Medical Inspection of Food Service Sanitation Facilities; pages 9–15
503	Insect and Rodent Control; Action in Disease Outbreaks; pages 15–26
504	Introduction to Nuclear, Biological, and Chemical Warfare; Medical Service Responsibilities During a Disaster; Radiation Fundamentals; pages 27–32
505	Nuclear Weapons Effects; Basic Principles of Radiation Protection; pages 32–38
506	Detection and Monitoring Instruments; pages 38–44
507	Radiation Monitoring; Decontamination; Biological Warfare; Chemical Warfare; pages 44–50

CHAPTER REVIEW EXERCISES

The following exercises are study aids. Write your answers in pencil in the space provided after each exercise. Immediately after completing each set of exercises, check your responses against the answers for that set. Do not submit your answers to ECI for grading.

CHAPTER 1

Objectives: To show a knowledge of the veterinary specialist's job as it relates foodborne diseases to various environmental factors, such as water supply, waste disposal, insect and rodent control, and food service; and to show an understanding of food service sanitation as it relates to foodhandlers and to the investigation of outbreaks of foodborne illness.

1. Why do foodborne illnesses occur? (1-2)

2. Compare food poisoning with foodborne infection. (1-4, *a,b*)

3. How do bacteria cause food poisoning? (1-6)

4. In what kinds of food and under what conditions would you expect staphylococcus to develop? (1-8)

5. What is the key to control of staphylococcus? (1-9)

6. What characteristics of the spore-forming organism, clostridium botulinum, make it particularly difficult to control in foods? (1-11)

7. On what is the prevention of botulism based? (1-13)

8. What kinds of food would you first suspect as contaminated in an outbreak of food poisoning where clostridium perfringens is involved? (1-15)

9. List five measures which are used in preparation and storage of meat and poultry dishes to prevent foodborne illness by clostridium perfringens. (1-17)

10. In addition to those produced by bacteria, what other kinds of poisons may contaminate food? (1-18, 19)

11. Of the organisms which cause foodborne infections, which is the most common? (1-21)

12. List five control measures which are effective with salmonella as well as with other foodborne illnesses. (1-24)

13. Streptococcal foodborne infections that are usually associated with foodhandlers are generally caused in what manner? (1-26)

14. What is the reservoir of the viral disease infectious hepatitis, and what are the sources of the infection? (1-27)

15. What food product is a prime source of brucellosis, diphtheria, Q-fever, or bovine tuberculosis? (1-29)

16. What 3 primary facets involved in the preparation and serving of food are of primary concern in preventing foodborne illness? (2-1)

17. What kind of examinations are given foodhandlers? (2-3)

18. What are medical examinations of foodhandlers designed to reveal? (2-5)

19. What condition of foodhandlers is assured by daily supervisory examination? (2-7)

20. If local circumstances necessitate the use of kitchen attendants as servers of food, what procedure must be maintained? (2-8)

21. What is probably the most important aspect of food storage? (2-10)

22. What are the time limitations within which leftover foods must be used? (2-12, *b*)

23. List eight foods that are considered to be particularly dangerous in regard to foodborne illnesses. (2-13)

24. What limitations are placed on the use of galvanized containers for food products? (2-15)

25. Which pathogenic organisms are removed or killed when proper dishwashing techniques are used? (2-17)

26. How may bacteria be detected on dishes and utensils that appear to be clean? (2-19)

27. When evaluating a mechanical dishwashing operation, what factor must be considered in addition to the machine's capability? (2-20)

28. What important dishwashing procedure is usually accomplished when racking dishes? (2-22)

29. During the washing cycle, why should the wash water temperature not exceed 160° F? (2-24)

30. What is the purpose of the nonrecirculating fresh-water rinse in mechanical dishwashing? (2-26)

31. If, after being washed mechanically, dishes do not become air dry in about 1 minute, what two conditions may be at fault? (2-27)

32. After washing, why should bowls, glasses, cups, and similar items be stored inverted? (2-29)

33. When hand dishwashing is accomplished by the hot-water method using a three-compartment sink, at what temperature must the water in the third compartment be maintained? (2-31)

34. Who conducts the training of foodhandlers in the principles and practices of food service sanitation? (2-33)

35. When could a 1-hour training class for all foodhandlers be effectively scheduled that would coordinate well with two operational shifts? (2-35)

36. In addition to a step-by-step development of the lesson, what other information should be stated in a lesson plan for training foodhandlers? (2-37)

37. When training foodhandlers, what two human elements must be presented as the most likely causes of foodborne illness? (2-39)

38. What are the two distinct aspects of responsibility of the veterinary program in insuring the safety of food and beverages dispensed from vending machines? (3-1)

39. List four food products that are prohibited for sale from automatic vending machines unless they are acidified below pH 5.0. (3-4)

40. Readily perishable foods or ingredients within vending machines must be maintained at what temperatures? (3-6)

41. If vending machines are located so there is adequate space between the machines and walls, what can be done to prevent insect and rodent infestation? (3-8)

42. When inspecting a vending machine for sanitary condtion, how can you determine when it was last serviced? (3-10)

43. Upon entering the base, what is required of vending-machine operators with respect to their products? (3-12)

44. Where may checklists be located to serve as standards for inspecting vending-machine products? (3-14)

45. If the sum of the points in column 2 of an inspection checklist for a vending-machine product plant is 50 and the sum of the points in column 3 is 10, what would be the sanitary compliance rating of the plant? Is this satisfactory rating? (3-16)

58. When you make an inspection of food service sanitation facilities, what should be your one broad objective? (5-1)

59. Upon what does your having a good working relationship with food service personnel depend? (5-3)

60. In addition to maintaining a friendly air while conducting an inspection of food service facilities, what other characteristics should you display? (5-4)

61. When you arrive at a food service facility to make an inspection, what should you do *first*? (5-6)

62. At what time should foodhandling techniques and procedures be verified as hygienically adequate and proper? (5-8)

63. When and how should the floors of the dining hall be cleaned? (5-9)

64. When should kitchen tables that are used for food preparation be cleaned? (5-10)

65. What are the results of inadequate disposal of garbage and trash? (5-12)

66. List some tests you may use to check for cleanliness of various surfaces. (5-13)

67. Why should you, before the inspection critique, check the files for copies of work order requests? (5-15)

68. How should you use a form during an inspection? (5-16)

69. During inspection, how, or with what regard, should you consider discrepancies? (5-17)

70. As a veterinary specialist, in which insects and rodents are you particularly interested? (6-1)

71. What is your main function in controlling economic pest insects and rodents? (6-2)

72. Where are the responsibilities for various aspects of pest control defined? (6-3)

73. Who supervises pest control measures? (6-6)

74. What is one indication of heavy insect infestation? (6-7)

75. What is the advantage of storing materials on wood pallets instead of directly on the floor? (6-8)

76. How are economic pests classified? (6-10)

77. How may you use the book, *Yearbook of Agriculture*, US Dept. of Agriculture? (6-12)

78. In what manner are cockroaches adaptable? (6-14)

79. Where are cockroach eggs laid? (6-16)

80. What is the simplest method of making inspections for cockroaches? (6-17)

81. What is the most common cockroach entry into a building? (6-18)

82. Other than excellent sanitary practices, what is required to control cockroaches in established infestations? (6-19)

83. To which type of insecticides have roaches developed widespread resistance? (6-21)

84. Why are houseflies harmful? (6-22)

85. List three methods of transmission of disease by the housefly. (6-24–26)

86. What are the best measures for control of houseflies? (6-27)

87. Why should screen doors swing outward? (6-29)

88. How can off-base fly breeding be controlled? (6-30)

89. If all of their offspring lived, how many flies could one pair of houseflies produce from early spring to late fall? (6-32)

90. List some rodent-borne killer diseases. (6-33)

91. Which is the most common and largest of the domestic rats? (6-35)

92. Where does the roof rat harbor? (6-36)

93. What is the range of the smallest of the domestic rodents—the house mouse? (6-37)

94. What habit that rats have makes it easy to determine if they are present in the vicinity? (6-40)

95. You see a greasy rubmark along a regularly traveled runway on a low wall beam. Is this runway most probably that of mice or rates? (6-41)

96. Rats *must* gnaw. Why? (6-43)

97. What may you do to determine rodent activity of a particular runway? (6-44)

98. List the best rodent-prevention measures. (6-45)

99. How can an effective and permanent control of rats and mice be attained? (6-47)

100. How can rodents be eliminated? (6-48)

MODIFICATIONS

Pages 11—17 of this publication has (have) been deleted in adapting this material for inclusion in the "Trial Implementation of a Model System to Provide Military Curriculum Materials for Use in Vocational and Technical Education." Deleted material involves extensive use of military forms, procedures, systems, etc. and was not considered appropriate for use in vocational and technical education.

ANSWERS FOR CHAPTER REVIEW EXERCISES

CHAPTER 1

1. Persons who prepare and serve food fail to apply known food protection measures.

2. Food poisoning develops abruptly due to preformed elements (either organic or inorganic, including bacterial toxins) whereas foodborne infection has a delayed onset from infection by microorganisms. The severity of food poisoning is related to the amount of toxic food consumed, whereas the severity of foodborne infections may develop by multiplication of the organisms after ingestion.

3. By releasing toxic products into the food.

4. Staphlycocci grow and reproduce rapidly in warm, moist, high-protein foods, such as custards, cream-filled pastries, meats, and eggs; and in salads made from meats, eggs, or mayonnaise.

5. Prevention.

6. The organism grows under anaerobic conditions, and must be boiled for 5 hours at 212° F. or 40 minutes at 221° F. (pressure cooker) to be killed.

7. Proper preparation of vulnerable foods.

8. Meats (including poultry), and products prepared from meat.

9. *a.* Serve hot immediately after preparation.
   b. Cool (below 45° F.) leftovers rapidly and reheat (above 140° F.) them rapidly.
   c. Use a meat thermometer to insure adequate thorough cooking of thick cuts and interior portions.
   d. Limit depth of stews, gravies, etc., to 4 inches for refrigerated storage.
   e. Insure proper techniques of handling and cleaning of vegetables and poultry.

10. Chemical poisons (organic and inorganic).

11. Salmonella.

12. *a.* Cleanliness of food and foodhandlers.
    b. Noninfected foodhandlers.
    c. Proper handling, thorough cooking, and adequate storage of susceptible foods.
    d. Use of pasteurized dairy and egg products.
    e. Use of eggs whose shells have not been cracked.

13. Streptococcus causes sore throats and scarlet fever in foodhandlers, who can transmit the organisms to food through droplet infection when talking, coughing, and sneezing.

14. Man is the reservoir of infectious hepatitis, the feces, urine, and blood of infected persons are the sources of the infection.

15. Raw milk.

16. Foodhandlers, facilities, and equipment.

17. Medical examinations and examination by food service supervisory personnel.

18. Chronic illness or medical problems that exist at the time the examination is made.

19. The hygienic standards and physical health are maintained.

20. Supervisors must maintain maximum surveillance over the operations in which they are engaged.

21. Temperature control.

22. Within a 24-hour period.

23. Hash, creamed soups, gravies, dressings, bread puddings, certain cheese or egg casseroles, and creamed meats.

24. The use of galvanized containers is limited to the transportation and temporary storage of water, peeled raw potatoes in water, and dry foods.

25. All pathogenic organisms, including the most resistant spores.

26. By using laboratory procedures

27. The work habits of the person who operates the machine.

28. Removal of gross soil.

29. Detergent activity is decreased if the water temperature exceed 160° F.

30. It provides thermal sanitization that protects food contact surfaces from pathogenic organisms.

31. The finished dishes may not be hot enough, or poor circulation of air may be causing high humidity.

32. To minimize the chance of contamination.

33. 180° F.

34. The base veterinarian or other qualified Medical Services personnel.

35. The last hour of the morning shift (for those working on the afternoon shift), and the first hour of the afternoon shift (for those working on the morning shift).

36. An objective of what the student is expected to learn from the lesson.

37. Sloppy habits and faulty techniques.

38. First, the machine, operator, delivery vehicle, and area in which the machine is located; and, second, the plant facilities and personnel involved in preparing, packaging, and storing the products for the machine.

39. Ham salad, egg salad, chicken salad, and cream-filled pastries.

40. At less than 45° F. (for cold foods) or more than 140° F. (for hot foods).

41. The machines may be sealed to the floor.

42. A record of all cleaning and sanitizing should be maintained at each machine by the operator.

43. Upon entering the base, operators are required to stop at the veterinary office to have their products inspected.

44. Inspection checklists are contained as an appendix to the applicable Military Standard for the product.

45. Eighty (80); no, the rating would not qualify the plant for listing in the *Directory of Sanitarily Approved Establishments for Armed Forces Procurement*.

46. Preflight, in-flight, and postflight feeding.

47. They should be well-cooked and low in residue, and they should not contain excessive fat or spices.

48. Flight attendants.

49. Three hours.

50. Three years.

51. Four months at 0° F.

52. The hour, date, and year prepared.

53. If not refrigerated, bread could act as a warm blanket which would promote growth of organisms which might be present on the filling material.

54. Five hours.

55. A dial thermometer, flashlight, disk comparator for chlorine residual, clipboard, inspection forms, carbon paper, and ballpoint pen.

56. Insure that they have a current medical examination and are able to pass an inspection pertinent to personal hygiene.

57. Recommend that the aircraft be delayed until the correction is made.

58. To *help*.

59. Upon your gaining the respect of food service personnel.

60. Good manners, military formality, a firm attitude, and meet or exceed the standards of appearance, health, and personal hygiene required of foodhandlers.

61. Contract the individual in charge.

62. During the preparation and serving periods.

63. They should be carefully swept, using a sweeping compound, or mopped with a damp mop after each meal.

64. They should be thoroughly cleaned and sanitized after each use.

65. The presence of flies, roaches, and rodents.

66. The finger-plate culture, the rinse test for bottles, the swab test, the contact plate test, and the fluorochrome dye test.

67. They may show that efforts have been made to correct unsatisfactory conditions—these work order requests should be mentioned in your report.

68. *Only* as a checklist to insure that you have observed all aspects of the operation.

69. With regard to their public health significance.

70. Those which affect food products.

71. To recognize signs of their existence, notify the proper agency, and request control measures.

72. In AFR 91–21 and AFR 161–1.

73. The base civil engineer.

74. Live insects in the areas around storage sites.

75. This allows easy rotation of stock so that the older material is used first.

76. Those that infest grains and cereals, and those that infest dried fruits and vegetables.

77. You may get complete information relative to economic pests.

78. They can fit themselves into almost any living condition.

79. In capsules, and they may be found glued to undersides of drawers and cabinets.

80. Walk quietly into a kitchen or storage area at night and suddenly turn on the lights.

81. They are usually in containers brought in from other areas.

82. Chemicals.

83. To the chlorinated hydrocarbon type.

84. They transmit many filth-borne diseases—such as typhoid, cholera, and dysenteries.

85. By carrying the germs on their feet, by vomitus ejected during feeding, and by defecation.

86. Those directed at cleaning up or removal of breeding sites.

87. To push away flies which may be clinging to the screen instead of admitting them into the house.

88. Only through the local Health Department.

89. Billions!

90. Murine typhus fever, plague, leptospirosis, rat-bite fever, salmonellosis, and rickettsialpox.

91. The Norway rat (Rattus norvegicus)—a burrowing rat.

92. Above ground; in attics and walls; in enclosed spaces of cabinets and shelving; and outdoors in trees and dense vine growth.

93. Frequently 10 to 30 feet.

94. They habitually use the same runways between food, water, and harborage.

95. Rats.

96. To keep their teeth short enough to use.

97. Put tracking patches of a dust material such as flour or talc along the runway.

98. Prevention of entry into building, cleanup of trash and debris, proper waste disposal and food storage, and elimination of food sources and harborage.

99. Only through a continuous sanitation program.

100. By combining sanitation methods with a killing program.

101. The Director of Base Medical Services and his staff.

102. To determine the cause of the outbreak and to break the chain of infection.

103. To prevent further cases resulting from the immediate offending food, to get pertinent information from the patients as quickly after the incident as possible, and to investigate while the infective or toxic food is still available.

104. What organism probably caused the outbreak; what foods were affected, and why; who prepared the food; and how could the outbreak have been prevented?

105. You look for the common denominator–the one meal common to all patients, and the one food or drink from the meal that *all* of the victims ate.

106. "Food Poisoning Outbreak–Individual Case History."

107. Follow the directive in AFM 161–6.

108. AF Form 432.

109. Have a laboratory bacteriological analysis performed on it and, if possible, on all of the food present at the offending meal.

110. Obtain a menu, thoroughly inspect the dining hall, interview and inspect dining hall personnel, and obtain food samples if they are available.

MODIFICATIONS

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STOP– **1. MATCH ANSWER SHEET TO THIS EXERCISE NUMBER.** **2. USE NUMBER 1 PENCIL.**

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VOLUME REVIEW EXERCISE

Carefully read the following:

DO'S:

1. Check the "course," "volume," and "form" numbers from the answer sheet address tab against the "VRE answer sheet identification number" in the righthand column of the shipping list. If numbers do not match, take action to return the answer sheet and the shipping list to ECI immediately with a note of explanation.
2. Note that numerical sequence on answer sheet alternates across from column to column.
3. Use only medium sharp #1 black lead pencil for marking answer sheet.
4. Circle the correct answer in this test booklet. After you are sure of your answers, transfer them to the answer sheet. If you *have* to change an answer on the answer sheet, be sure that the erasure is complete. Use a clean eraser. But try to avoid any erasure on the answer sheet if at all possible.
5. Take action to return entire answer sheet to ECI.
6. Keep Volume Review Exercise booklet for review and reference.
7. If *mandatorily* enrolled student, process questions or comments through your unit trainer or OJT supervisor.
   If *voluntarily* enrolled student, send questions or comments to ECI on ECI Form 17.

DON'TS:

1. Don't use answer sheets other than one furnished specifically for each review exercise.
2. Don't mark on the answer sheet except to fill in marking blocks. Double marks or excessive markings which overflow marking blocks will register as errors.
3. Don't fold, spindle, staple, tape, or mutilate the answer sheet.
4. Don't use ink or any marking other than with a #1 black lead pencil.

NOTE: The 3-digit number in parenthesis immediately following each item number in this Volume Review Exercise represents a Guide Number in the Study Reference Guide which in turn indicates the area of the text where the answer to that item can be found. For proper use of these Guide Numbers in assisting you with your Volume Review Exercise, read carefully the instructions in the heading of the Study Reference Guide.

Multiple Choice

Chapter 1

1. (500) What is a major reason why foodborne illnesses occur?

    a. Food protection measures are unknown.
    b. Carelessness of foodhandlers.
    c. Certain bacteria cannot be controlled.
    d. Growth of bacteria is promoted by good food preparation methods.

2. (500) How do bacteria cause food poisoning?

    a. By entering the individual's body with food.
    b. By destroying the nutritional elements of food.
    c. By releasing toxic products into the food.
    d. By infesting root type foods while they are growing.

3. (500) Which of the following is a characteristic of *Clostridium botulinum* spores?

    a. Aerobic.
    b. More prevalent in acid foods.
    c. Destruction requires boiling 5 minutes at 212° F.
    d. Destruction requires boiling 5 hours at 212° F.

4. (500) What is the most suitable mediums for staphylococcus organisms to grow and reproduce?

    a. Cool, dry, low-protein foods.
    b. Warm, moist, high-protein foods.
    c. Cold foods at temperatures below 40° F.
    d. Hot foods at temperatures above 140° F.

5. (500) What kinds of food should you first suspect in an outbreak of food poisoining where *Clostridium perfringens* is involved?

    a. Meats.
    b. Vegetables.
    c. Milk.
    d. Eggs.

6. (500) Which of the following is *not* an effective measure for controlling salmonella?

    a. Insure cleanliness of food and foodhandlers.
    b. Insure that foodhandlers are noninfected.
    c. Use nonpasteurized dairy products.
    d. Use eggs whose shells have not been cracked.

7. (501) Which of the following facets of food preparation and handling is *not* one of the primary inspection objectives for the prevention of foodborne illness?

    a. Origin of food.
    b. Foodhandlers.
    c. Facilities.
    d. Equipment.

8. (500) What is the reservoir of the viral disease, infectious hepatitis?

a. Housefly.
b. Man.
c. Rodent.
d. Food.

9. (501) Medical examinations of foodhandlers are designed to reveal

a. hygienic habits of the foodhandler.
b. foodborne illness infection of the foodhandler.
c. medical problems which exist at the time of examination.
d. state of immunity of the foodhandler to foodborne diseases.

10. (501) Galvanized containers can satisfactorily be used as a container for

a. temporary storage of water.
b. lemonade.
c. meat.
d. fruit.

11. (501) What is the general time limitation within which leftover foods should be used?

a. 4 hours.
b. 8 hours.
c. 12 hours.
d. 24 hours.

12. (501) What important dishwashing step should be accomplished when racking dishes?

a. Sorting of dishes.
b. Removal of gross soil.
c. Rinsing of dishes.
d. Thermal sanitizing.

13. (501) During the washing cycle of a mechanical dishwashing operation, why should the wash water temperature not exceed 160° F?

a. Detergent activity would be decreased.
b. Detergent activity would be increased.
c. Water hotter than 160° F. will cause dishes to break.
d. The dishes would be sanitized.

14. (501) The purpose of the nonrecirculating fresh water rinse in mechanical dishwashing is for

a. removal of gross soil.
b. removal of detergent.
c. thermal sanitization.
d. acceleration of detergent activity.

15. (501) When would a 1-hour training class for all foodhandlers be most effectively scheduled to coordinate well with two operational shifts?

a. After the end of each shift.
b. Before the beginning of each shift.
c. During the hour before the first shift (for the first shift), and during the hour after the second shift (for the second shift).
d. During the last hour of the first shift (for the second shift), and during the first hour of second shift (for the first shift).

16. (501) When hand dishwashing is accomplished by the hot-water method using a three-compartment sink, what is the *minimum* temperature at which the water in the third compartment must be maintained?

    a. 180° F.
    b. 190° F.
    c. 20[illegible].
    d. 212° F.

17. (501) When training foodhandlers, what two human elements must be presented as the most likely causes of foodborne illness?

    a. Deliberate mistakes and sloppy habits.
    b. Deliberate mistakes and faulty techniques.
    c. Sloppy habits and faulty techniques.
    d. Lack of training and deliberate mistakes.

18. (502) Where are checklists for inspecting food-processing plants contained?

    a. In AFR 163–2.
    b. At the command veterinarian.
    c. At the US Department of Agriculture.
    d. In the appendix of the applicable Military Standard.

19. (502) When inspecting a vending machine for sanitary condition, how can you determine when it was last sanitized?

    a. Examine the record maintained by the operator.
    b. By making a white-glove inspection.
    c. Estimate the time by assessing the physical condition.
    d. Make laboratory tests of specimens taken from the machine.

20. (502) Who is responsible for preparing and serving inflight meals on troop-transport aircraft?

    a. Aircraft crew.
    b. Airline hostesses.
    c. Flight attendants.
    d. Base food service personnel.

21. (502) At 0° F., what is the recommended safe storage life for precooked frozen meals?

    a. 1 month.
    b. 4 months.
    c. 6 months.
    d. 1 year.

22. (502) Why must the bread, as well as the ingredients, used in making sandwiches be refrigerated?

    a. Refrigeration improves the taste of bread.
    b. Warm bread serves to prevent growth of organisms.
    c. Warm bread serves to promote growth of organisms.
    d. To allow for using bread that would otherwise be too old.

23. (502) Which of the following items are necessary when performing a thorough sanitary inspection of an aircraft?

    a. Dial thermometer, flashlight, disk comparator for chlorine residual, and inspection forms.
    b. Microscope, flashlight, disk comparator for chlorine residual, and inspection forms.
    c. Dial thermometer, microscope, disk comparator for chlorine residual, and inspection forms.
    d. Dial thermometer, flashlight, microscope, and inspection forms.

24. (502) What should you do if, during an aircraft sanitary inspection, you find a discrepancy that is a health hazard which cannot be corrected immediately?

    a. Allow the aircraft to proceed to a location where the discrepancy can be corrected.
    b. Recommend that the aircraft be delayed until a correction is made.
    c. Make the best correction under the conditions; allow the aircraft to proceed.
    d. Recommend extreme precautions to be taken but do not delay the aircraft.

25. (502) When you arrive at a food service facility to make an inspection, what should you do *first*?

    a. Make a quick survey, utilizing the element of surprise.
    b. Proceed to inspect in first one direction, then another; do not use a set pattern.
    c. Carefully check the outside area before contacting anyone.
    d. Contact the individual in charge of the operation.

26. (502) Which of the following groups of tests can be used to check for cleanliness of surfaces?

    a. Safranin dye test, salt test, tissue test, and disk comparator test.
    b. Safranin dye test, salt test, disk comparator test, and rinsability test.
    c. Safranin dye test, salt test, tissue test, and rinsability test.
    d. Safranin dye test, disk comparator test, tissue test, and rinsability test.

27. (502) When should the floors of the dining hall be cleaned?

    a. After each meal.
    b. Before each meal.
    c. At the end of each day.
    d. At the beginning of each day.

28. (502) The significance of discrepancies found while inspecting a food service facility should be based on

    a. the number of discrepancies found.
    b. their health hazard potential.
    c. the causes of the discrepancies.
    d. the attitude of management toward relieving the discrepancies.

29. (503) What is your main function in controlling economic pest insects and rodents?

    a. Recognizing signs of pests and destroying them.
    b. Notifying the proper agency, requesting permission for control measures, and destroying the pests.
    c. Recognizing signs of the pests, notifying the proper agency, and requesting control measures.
    d. Recognizing signs of pests, notifying the proper agency, and destroying the pests.

30. (503) Into what two groups are economic pests classified?

a. Those that infest grains and cereals, and those that infest dried fruits and vegetables.
b. Those that infest grains and cereals, and those that infest meat and meat products.
c. Those that infest dried fruits and vegetables, and those that infest meat and meat products.
d. Those that infest dairy products, and those that infest meat and meat products.

31. (503) To which type of insecticides have roaches developed widespread resistance?

a. DDVP.
b. Diazinon dust.
c. Malathion sprays.
d. Chlorinated hydrocarbon insecticides.

32. (503) Rodents may serve as reservoirs for all of the following diseases *except* for

a. botuliam.
b. leptospirosis.
c. salmonellosis.
d. murine typhus fever.

33. (503) In which instant are rodent-killing methods the *least* effective?

a. Before sanitation or cleanup programs are begun.
b. After dusting with an approved pesticide for fleas control.
c. After vent stoppage work to eradicate rodents in buildings.
d. When good sanitation methods are not used.

34. (503) You see a greasy rubmark along a wall beside a regularly traveled runway at floor level. What kind of rodent probably has used the runway?

a. Mice.
b. Norway rat.
c. Roof rat.
d. Field rat.

35. (503) Which of the following is *not* a recommended procedure for rodent prevention?

a. Proper waste disposal.
b. Proper food storage.
c. Placing talc along runways.
d. Elimination of food sources.

36. (503) What is your objective, as a veterinary specialist, during a food poisoning investigation?

a. To determine the cause and break the chain of infection.
b. To determine the cause and treat those infected.
c. To break the chain of infection and treat those infected.
d. To treat those infected and provide a basis for educating those involved.

37. (503) Who can furnish the information required to complete AF Form 431, "Food Poisoning Outbreak–Individual Case History"?

a. The physician.
b. The infected person.
c. The Food Service supervisor.
d. The person who prepared the food.

38. (503) How can you confirm that the suspected food is the carrier of the infection?

a. Make an odor test of the suspected food.
b. Make a taste test of the suspected food.
c. Make a random laboratory analysis of the foods served.
d. Make a laboratory analysis of all the foods served.

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